University of Alberta Library
0 1620 3448002 8

For Reference

NOT TO BE TAKEN FROM THIS ROOM

Ex libris
Universitatis
Albertaensis

1925
6

"Contribution to the Experimental Study of Memory."

A Thesis Presented in Partial Fulfilment of the
Requirements for the Degree of Bachelor
of Education, University of Alberta,
by
William Line.

August, 1925.

UNIVERSITY LIBRARY
UNIVERSITY OF ALBERTA

OUTLINE.

Pages

1. Introduction. Purpose of the essay. 1 - 4
2. Summary of past investigations in the field of memory. 4 -31
3. Some common conceptions of 'Memory' 32 -42
4. Behaviouristic interpretation of 'Memory'and'Meaning' 42-49
5. Relation of Memory to Intelligence 49-52
6. Criticism of McDougall's conception of 'Meaning' 53 -57
7. A few implications of the theory which is accepted here: (a) Relation between immediate and delayed reproduction 58 -60
   (b) Reminiscence 60 -61
   (c) Testing and Training of Memory 61 - 62
8. Criticism of test material used up to the present time,- Nonsense syllables 62- 70
   Letters, words, digits 70-71
   Objects, pictures etc 71-72

Pages

9. Methods of Memorising 72 - 76

10 Criticism of former investigations of 'logical memory' Suggested improvements from the point of view of material 77 - 85

11 Methods employed in the present investigation 85 - 94

12 Results and Conclusions 94 - 104

13 Criticism of this experiment 105 - 108

14 Further problems 109 -135.

15 Appendix I Passages used in this investigation pp i-xvi

16 Appendix II Data, graphs, tables, pp xvii-xli

17 Index of Authors quoted in this essay pp xlii-xliii

18 List of books consulted in preparation of this essay p xliv

The main purpose of the experimental work here reported, was to isolate a few further problems in the field of Memory, and to make suggestions as to new methods of attack. In order to do this, it was necessary to determine the degree of agreement that exists among the results of previous investigations, and to estimate the precise meaning and importance of the data which past experiments have given. Such a task is obviously concerned especially with the nature of the material that has been used, as well as with the methods that have been employed; and since the importance of the particular experiment with which this essay is concerned, depends especially on the type of material selected, it will be necessary, at the outset, to consider briefly that phase of past investigations.

A detailed analysis of the whole of the research that has been done to date in this field, need not be made here. Methods of presentation may vary considerably; the manner in which efficiency is scored

Digitized by the Internet Archive
in 2018 with funding from
University of Alberta Libraries

https://archive.org/details/contributiontoex00line

changes according to the phase of the work which is being measured; and numerous other variables are involved, making the entire field decidedly complex. But if we select, for special study, the material that has been used, and then compare the results and conclusions furnished thereby, a few problems present themselves, the solution of which would indeed add greatly to our present knowledge concerning the nature of memory, and its efficient use in school work. Accordingly, the most significant experiments from this point of view,are reported, in an attempt to indicate more clearly the exact nature of the suggestions and conclusions which this paper offers.

The main subdivisions under which memory investigations have been conducted are (a) Rote, and (b)'Logical' memory. The distinction thus made is obvious, the first type involving the reproduction in correct order, and exactly as presented, of a series of discrete impressions, (e.g. letters, digits, words, etc.); while the second applies to the

reproduction of the substance or meaning of a logically connected whole, (e,g. a poem or a passage of prose). Both types may be considered from the standpoint of either immediate or delayed reproduction, - i.e. they may involve either the instantaneous reproduction of impressions which have not yet been displaced in consciousness by other presentations, or the reproduction after an interval of time, which varies, of course, from a short period to one of considerable length. This is a necessary feature of the study, since individuals differ markedly with respect to these forms; and other factors, such as concentration of attention, duration and repetition of impressions, etc., operate in such a way as to make them quite distinct.

In the case of rote memory, particular varieties of memory have been distinguished, and investigated separately, - the so-called 'special memories', - such as memories for objects, sounds, words of certain content, abstract terms, ideas, numbers, emotions, volitional acts[1], etc.,etc. These memories develop at

[1] Cf. Rusk, 'Experimental Education', p. 85

different ages, and are distinguishable as different traits in individuals; and one may be destroyed or obliterated without affecting the others.[2] Hence they may be regarded as separate memories; and investigators have recognised this fact. We may note also in passing that other problems which have been studied in this connection are : individual differences as conditioned by sex, age, and mental ability; the detection of fatigue; the nature of practise, the possibility of training retention and recall, the most economical methods of learning[3], the relation of immediate to prolonged retention, and the correlation between memory and general intelligence, etc.

The earliest work of note, with respect to the 'special memories', was that of Netschajeff,[4] who experimented on 687 St. Petersburg scholars, aged nine to nineteen. Lobsien[5] carried out similar experiments in Kiel on 426 scholars whose ages ranged from eight to fourteen. The former massed the results obtained from testing pupils of six institutions of

[2] Meumann: 'The Psychology of Learning.' English Trans. pp. 46-48

[3]. Whipple: 'Manual of Mental and Physical Tests.' Vol. II. p. 150.

[4]. 'Zeitschrift für Psychologie'. vol. xxiv. [Quoted from Rusk, op. cit. p. 85]

[5]. Ibid. vol. xxvii [Quoted from Rusk, op. cit., p. 85]

different types; while the latter, more wisely, confined himself to pupils of the elementary schools of Kiel.

The material used, and the methods employed, were as follows. Netschajeff first of all presented twelve different objects, such as are used in observation lessons, e.g. handkerchief, pen-holder, book. These were shown to the ~~twelve~~ children, each for two seconds. They were then covered, and the pupils had to write down the names of the objects they remembered. Thus was determined the immediate memory for objects. Memory for sounds was measured by producing twelve sounds with different instruments behind a screen, - e.g. clapping of hands, knocking, tearing silk cloth, stamping, whistling, etc., - and the children had to write down what they remembered. Twelve numbers of two digits were next pronounced, and likewise transcribed. These were followed by groups of words, invariably trisyllabic. First, twelve trisyllabic words of preponderatingly visual content, - that is, denoting objects usually apprehended visually by a

normal person, such as, 'pencil', 'calendar', 'scissors', 'bottle', etc. (The Russian equivalents were all trisyllabic.); next, twelve words representing auditory presentations, e.g. 'music', 'song'; then, twelve words denoting touch, temperature, and muscular experiences, e.g. 'smooth', 'round', 'cold'; then, emotional terms, - e.g. 'care', 'joy', 'hope', 'sadness'; and lastly, twelve abstract conceptions, such as 'space', 'cause', 'quantity,' 'quality.' Lobsien reduced the number of words to nine, and did not restrict himself to trisyllabic terms. His objects were exposed for five seconds, and the impressions were required to be written down in the order given. By confining himself to elementary school pupils, he made his averages more reliable; but his results are in general agreement with those of Netschajeff.[6]

These experiments established the fact that there are periodic variations in the development of these special memories, periods of rapid progress, of arrest, and of retrogression. Sex differences were likewise demonstrated, especially in regard to the

[6] Cf. Rusk, op.cit., p. 86.

order in which these special memories develop. Even in investigations of so definite a nature, however, there is some lack of agreement as to the results. For instance, Netschajeff claims that boys possess a stronger memory for objects directly perceptible, girls, a stronger memory for numbers and words; while Lobsien's results point to the superiority of girls at all ages in respect to all the special memories, with the exception of that for unintelligible terms.[7] These differences may be accounted for, at least in part, by the varied nature of the groups tested, and by the inequality of the material used.

In investigating immediate reproduction, actual objects were used also by Kirkpatrick,[8] (groups of ten) (Lobsien[5] had used nine, and Netschajeff,[4] twelve). Pictures of objects, (ten in number), were used by Miss Calkins[9]; groups of twenty, by Mrs. Squire,[10] and by Carpenter[11]. Words, as already noted, were used by Lobsien[5] and Netschajeff.[4] They ~~were~~ may be employed in a variety of ways, and for numerous purposes. Wessely,

[7] Rusk. op. cit. p.87.

[8] E.A. Kirkpatrick: 'An Experimental Study of Memory.' Psychological Review, I 1894, 602-9. [Quoted from Whipple, op. cit., p. 153.]

[9] Psychological Review V, 1898, 451-6 " " "

[10] Journal of Educational Psychology, 3, 1912, 377-380 [Quoted from Whipple, op. cit, 153]

[11] " " " " , 4, 1913, 538-544 " "

for example, used them in constructing a 'vocabulary' form of test;[12] Kirkpatrick[8], Calkins[9], and Pohlmann,[13] used 10-term series of words that related to objects; Hawkins[14] compared simultaneous and successive exposure of 15 nouns; while Ritter[15], Simpson[16], Abelson[17], Lapie[18] and Sharp[19] employed lists of words of varied length and complexity. Distinction was first made by Norsworthy[20] and Bergstrom[21], between 'related' or 'associable' terms, and 'unrelated' or 'dissociable' terms, e.g. 'paper', 'writing', 'compose', etc., versus 'horse', 'bricks', 'soldier', 'acorns', etc. Bolton[22] used short lists of monosyllabic words, while Binet[23] used seven series of seven words each. Meumann[24] investigated the maximum of immediate retention in a more systematic fashion, by reading aloud to the children, first three, then four, then five, and so on up to eight words, which had to be at once transcribed. In this way Burt[25] and Pyle[26] compared the span (3 - 8 term series) for concrete nouns, (e.g. 'stove', 'ink', 'lamp', etc) with the span for abstract nouns, (e.g. 'influence', etc)

[12] Wessely: 'Neue Jahrbücher f. Padagogik' 8, 1905, 297-309. [Whipple, op.cit., 153]
[13] 'Zeitschrift. für Psychologie', 44, 1907, 134-40. [Whipple. op. cit. 153]
[14] Psych. Review 4, 1897, 289-294.
[15] Zeits. f. Psych. 24, 1900, 401-444.
[16] B.R. Simpson: 'Correlations of Mental Abilities'. Columbia Contributions to Education, No. 53, New York 1912, p. 122.
[17] Brit. Journ. Psych. 4, 1911, 268-314.
[18] L'Année Psychologique, 18, 1912, 238-240.
[19] Amer. Journ. Psych. 10, 1899, 329-391.
[20] N. Norsworthy: 'The Psychology of Mentally Deficient Children', New York, 1906, p.11

Letters also have been employed by many investigators, - the general tendency being to use consonants only, thus avoiding the formation of syllables and words. Winch[27] exposed sets of twelve consonants for 25 seconds. Variety of procedure here again is clearly illustrated by noting that Binet[28] used fifteen consonants exposed visually and simultaneously for 20 seconds; Cohn[28] exposed twelve consonants arranged in the form of a square for 25 seconds; Pohlmann[28] ~~used~~ read ten consonants to his subjects three times over; Sharp[28] exposed twelve letters successively at the rate of one per second, and repeated until the series was learned; Smith[28] exposed twelve consonants simultaneously for 10 seconds, and read other series of four, five, six, seven, and nine term consonants; Wyatt and Anderson used the letter-square method.[28] Sharp, Jacobs, Finzi, and others have also employed letters in similar investigations.[28]

Two-place numbers have been mentioned in connection with the work of Lobsien[5] (nine numbers), and Netschajeff[4] (twelve numbers). They were also

[21] Amer. Journ. Psych. 18, 1907, 206-238. (Quoted from Whipple, op. cit., p. 153)
[22] Ibid. 4, 1892, 362-380 " " " "
[23] L'Année Psychologique, 1, 1894, 1-23. " " " "
[24] Rusk, op. cit. p. 88. Also, 'Die experimentelle Pädagogik.' 1, 1905, 35-101.
[25] Brit. Journ. Psych., 3, 1909, 94-177.
[26] W. H. Pyle: 'The Examination of School Children', New York, 1913, pp. 14-17.
[27] Brit. Journ. Psych. 1 p. 128. Also Rusk. op. cit., p. 88.
[28] Whipple op. cit., p. 153.

used by Schuyten,[29] and by Pohlmann.[29] Digits have been employed by Jacobs, Johnson, Bolton, Binet, Hawkins, Ebbinghaus, Ritter, Chambers, Kohnky, Lapie, Sharp, Smedley, Krueger, Spearman, Wissler, and many others.[29] Binet first rejected the oral method of presentation in favor of the visual, owing to the difficulty of speaking without accent, or without grouping the digits.[30] Geometrical Drawings, familiar and unfamiliar, formed the material in certain experiments by Munsterburg, Bigham, Bernstein, and Bogdanoff;[29] lines of varied length have been used by Toulouse, and by Binet;[29] miscellaneous visual characters, symbols, combinations of dots, lines, etc., were used by Ebert and Meumann;[29] and memory for commissions forms a well-known part of the Binet - Simon tests.[31] The latter idea has been used by Abelson[29] in devising a memory-span test, in the study of backward children.

Sentences have also functioned in this phase of the work, especially since they were successfully used by Binet.[32] (See also Page 21). Among those who

[29] Whipple, op. cit. p. 154.

[30] Ibid. p. 157 footnote.

[31] Cf Terman: 'The Measurement of Intelligence', Chapters I-IV.

[32] Rusk, op. cit., p. 88.

have adopted them, are Ritter, Miss Sharp, Mrs. Squire, Carpenter, and Abelson.[33] But perhaps the most notable material that has been employed in the experimental study of memory, is that which was made famous by Ebbinghaus, - Nonsense Syllables. A discussion on this special feature of the work will be found later, (page 62-70). At this point we would note that Jacobs, Cohn, and Dieffenbacher tried nonsense syllables, but discarded them.[33] They formed, however, the stock material in Ebbinghaus' pioneer work[34], and were subsequently made more serviceable by the precise rules that Muller and Schumann[33] formulated for their construction. Bergstrom, Burt, Smith, Pohlmann, Lewis, van Biervliet[33] and others claim to have found them of value.

Such are the main types of material that have been employed in tests of rote memory. The most significant results of the investigations will next be briefly considered. We have already seen that while the results obtained by Netschajeff and Lobsien are not absolutely in agreement, the general findings are

[33] Whipple, op. cit. p 153

[34] Ebbinghaus, 'Memory', English Trans. Chap. 3. Cf. Meumann: 'The Psychology of Learning,' English Trans., pp 160-164.

fairly consistent.[35] The period between the fourteenth and fifteenth years appears to be the most favourable for all of these memories, and Lobsien's results point to the fact that the greatest relative increase of immediate memory capacity occurs between the tenth and twelfth years. The special memories develop at various rates with children, and differ with boys and girls. Young children from nine to fourteen years of age possess a surprisingly feeble memory for emotions, and this weakness lasts until the puberty stage. The development of the memory for abstract conceptions proceeds parallel with that for numbers, whereas the memories for objects and sounds are distinct from, and precede, those for words and numbers,The special memories may be arranged in the following order of development : with boys, the memory for objects is first developed, then words of visual content, words of auditory content, sounds, terms denoting tactual and motor experiences, numbers, abstract conceptions, and lastly emotional terms; with girls, the order is words

---

[35] Cf. Rusk, op. cit. pp. 86-87.

of visual content, objects, sounds, numbers, abstract conceptions, words of auditory content, terms denoting tactual and motor experiences, and emotional terms.[36] Meumann[36] believes that boys are more disposed to think abstractly, and girls to employ concrete imagery. The most striking difference between the memories of boys and girls appears between the ages of eleven and fourteen; during this period, the memory development of girls, is, on the average, considerably superior to that of boys, but from fourteen onwards the boys approximate to, and then overtake the girls.

Netschajeff's[37] work also established the fact that there is a connection between the memory development and the physical development of the child; and Meumann[38] declares that we are justified inconcluding that children of good physique are specially favoured for memory work.

It would appear that the child's capacity for immediate memory improves with age, but that through-

---

[36] Rusk. op. cit. p. 87

[37] Ibid. p. 88

[38] Vorlesungen, vol. i p. 429. Quoted from Rusk op. cit., p. 88

out the whole of school life it is much less than that of the adult. The development is very slow, and has not reached its maximum when children leave school. Meumann's tests with both children and adults indicate that the development is slow up to the age of thirteen, is more rapid from thirteen to sixteen, and that the maximal point is reached at twenty-two or twenty-five.[39]

Lewis[40] compared the results obtained by using both sense and nonsense material, with a view to discovering whether children were compensated for their lower degree of intelligence by an increased ~~memory~~ endowment in respect of 'brute' memory for unintelligible material. He found no such compensation; and accordingly he infers that the greatest importance should be attached to the clear and systematic apprehension of the form and meaning of the matter which has to be memorised.

We have seen that experiments tend to the conclusion that the school-child's capacity for memorising is inferior to that of the adult. With prolonged

39. Cf. Rusk. op. cit p.89

40 'Report of Proceedings of L.C.C. Conference of Teachers' 1910, p.13. [King, London]. Cf. Rusk. op. cit., p.89.

retention, however, the reverse is the case. The child retains what is learned very much longer than the adult. The results of the work of Wessely[41], Meumann[41], and Springer[42] indicate that the curve representing the development of retentiveness reaches a maximal point during the school life of the child, (-between the eleventh and thirteenth years.) But there is some lack of agreement as to the age at which this curve starts to fall. Thus the popular notion that the child has a better memory than the adult, appears to be erroneous as regards memorising, but is justified in respect to retentiveness. Hence the pedagogical conclusion that formulae, etc, which have to be employed continually and remenbered throughout life, should be learned at the most favourable age for retention.

The relation of Immediate to Prolonged Retention has been investigated by Lewis[40], who used both sense and nonsense material. The coefficients of correlation in the case of sense material were .64, .81, and .76 respectively for the ages eight, ten and twelve; for

---

[41] Rusk, op. cit. p. 91 Cf. Meumann, 'Vorlesungen', vol. i. pp. 460-462.

[42] Journ. of Educ. Psych. vol. v. p. 420.

the nonsense material, the coefficients were .78, .75, and .84. In this experiment, it was found that the pupils who memorised most on the first day were those who reproduced most on the second day. The reproduction on the second day, however, was preceded by one additional repetition of the material. So that the conclusion woulh here seem to be that rapid learners are rapid re-learners. Other experimenters, (for example, Meumann,[43]) have found that if the rapid learner is called upon to reproduce freely without relearning, he appears to be at a disadvantage as compared with the slow learner. Meumann maintains that the typically rapid learner is usually a rapid forgetter; and among his illustrative cases is that of a rapid learner who was unable to reproduce a series of syllables two minutes after learning it. When allowance is made for this rapid forgetting by delaying reproduction for a time, (say, up to two minutes after learning,) the rapid learner shows poor immediate retention; and hence a higher correlation between

[43] 'Psychology of Learning', English Trans., pp. 169-174.

immediate reproduction and prolonged retention results. Pyle[44] instances cases of rapid learners who are able to retain well; and these clearly possess the most efficient type of memory. The experiments reported later in this paper would, on the whole, seem to support the contention that the popular idea, 'easy come, easy go', is false.(See page 104).

One further problem with reference to rote memory may be noted. The correlation of memory with general intelligence has received the attention of Bolton[45], Meumann[45], Ebbinghaus[45], Winch[45], Burt[46], and others. There is at present, however, no unanimity of opinion. Bolton claims that memory development does not proceed parallel to development of intelligence, but is dependent on age. Meumann found that, in general, the more intelligent children possessed superior memory ability. Ebbinghaus claims to have found an inverse correlation, and Burt a correlation which, while considerable, is not of a high degree. Meumann and Burt differ again in that the former obtained

[44] Journ. of Educ. Psych. vol. ii. pp 311-321.

[45] Rusk, op. cit., pp. 92-93.

[46] Brit. Journ. of Psych., vol. iii p. 143.

results indicating that the superiority of abstract to concrete memory is a strong mark of intelligence, while Burt's results do not confirm this claim. Winch concludes from his work that memory and general intelligence are highly correlated.

There are several reasons why these conclusions are of so contradictory a nature. The material used was very varied, as is seen by the fact that Ebbinghaus based his contention on an auditory test, Winch used a visual test, Burt used abstract and concrete words, and nonsense syllables,(presented visually as well as orally,) Meumann used words, and Bolton used mainly digits and mono-syllabic words, in testing memory capacity. Further, the need for more satisfactory methods of measuring general intelligence, makes the results more unreliable. It may be, as Lewis suggests, that in attempting to estimate this degree of correlation we are merely working in a circle, since general intelligence is doubtless involved in the majority of memory tests.(A theoretical discussion of this relation will be found on page 49).

The Substance Memory, - generally known as 'Logical'Memory , - has not received the same attention as the rote memory. This is perhaps surprising when we consider the vital importance of this field in all school work. The tendency in teaching has been for some time to place the emphasis on 'substance memory', and less on the mechanical aspect. Consequently the opportunities for further work on this phase are very great indeed; and our future methods must be based on a scientific notion as to just what we are testing.

Tests of Substance memory differ from the preceding type in two respects. In the first place, the material that is used constitutes a connected meaningful whole, instead of a series of disparate impressions; and secondly, what is required is not an exact verbatim reproduction of the original presentation, but primarily a reproduction of the *ideas* that are contained in the passage. We have seen that short sentences have been used (page 12) in

investigating rote memory, and it is of course necessary that such material should not be of too great a length, since in that case the reproduction would involve substance rather than rote memory. The distinction that has been made hitherto is quite clear, however, as regards methods in the two cases; for short, easy sentences (e.g. of eleven or twelve words,) are almost invariably interpreted by the subject as a test of verbal memory, and the reproduction is mainly a recall in auditory and verbal terms. Tests of substance memory are invariably of such a length as to make verbatim reproduction practically impossible. A more careful analysis is necessary, it is true, in order that the distinction between rote and substance memory may be made more clear; but for the present we shall confine ourselves to ~~with~~ what has been done up to now. (For a discussion on the theoretical aspect of the question, see page 42).

The purposes of the experiments in this case are similar to those of other memory tests, namely,

to determine individual differences in memory efficiency as related to sex, age, training, native ability, etc.[47] Distinction is made between immediate and deferred reproduction, and the results have been correlated with the results of other tests. The Binet-Simon series of tests of 1908,[48] introduces the 'Story of the Fire' at the eighth and ninth years. Wissler[49] uses a logical memory test in his series applied to Columbia University Freshmen,; Terman,[49] in his comparative study of bright and dull boys; Winch,[49] in the investigation of fatigue in evening schools, and as a control test in a transfer of training investigation; Simpson, in his comparison of competent and incompetent adults. Henderson,[50] who has perhaps made the most elaborate investigation of 'memory for connected trains of thought', administered a series of tests to over two hundred subjects, ranging from ten-year-old fifth-grade children to adult university students. He found that whereas adults surpassed children in immediate reproduction, the reverse is the case with

[47] Cf. Whipple, op.cit., pp. 205-221.

[48] See Terman: 'The Measurement of Intelligence'.

[49] Whipple, op. cit. p. 206.

[50] Columbia University Thesis. See Whipple, op. cit., p. 206.

deferred reproduction. He also found a positive correlation between learning capacity and retentivity, and no significant correlation between memory and intelligence. Shaw, Pyle, and Aall[49] have also attempted to establish age and sex norms by using sensible material.

Further details of these studies are not necessary here. But apart from them, there is little that has been done; and it is obvious that the subject of sensible memory would repay further investigation. With a view to showing the general purpose of past work in this connection, however, it would seem advisable to include here the following brief summary of the results.

The work of Shaw and of Pyle[51] appears to show that 'logical', like rote memory, seems to be at its best near puberty, when measured by the first reproduction. Sex differences are in favour of girls, according to Shaw, Wissler, Pyle, and Schramm, while Vos and Aall do not agree with this.[52] Whipple and Aall claim that the insertion of a time-interval between presentation and reproduction has much less

[51] Whipple, op. cit., p 212.

[52] Ibid. p.213.

effect upon memory for ideas than upon memory for discrete impressions.[52] Usually, if a second reproduction is called for one day after the first, more words are written, but there is a slight reduction in the number of ideas reproduced. The tendency appears to be to become slightly more verbose, but less precise. Aall points out that frequently, ideas omitted from the first reproduction come to light in the delayed one, due to the existence of 'a sort of after memory'.[53] (Cf. Ballard's experiment, page 29) Aall further noted that names of places are lost sooner than memories ~~for~~ of objects.[53]

owing

It is generally agreed that with sensible material, the notion 'easy come, easy go' is false, but individual differences are less in subsequent recall than in original speed of learning. According to Binet and Henri,[54] the number of words reproduced after one hearing increases, though not in direct proportion, with the length of the passage heard. Shaw[54] found that if the original passage be divided into sections of equal length, the reproduction of

[53] Ibid. p. 214

[54] Ibid. p. 216

any one of these portions is inferior to the one that precedes it, and superior to the one that follows it; but Dell[54] found a slight rise at the end. Various other interesting features have been noted, without, however, resulting in definite agreement. Among these may be mentioned: the correlation between substance memory and memory for words;(Simpson[55] found this to be .80, from which he concluded that memory for words and substance memory are virtually the same capacity.); the relation between substance memory and intelligence - the results being very low; (Wissler .2, Pyle .3, Simpson .35[56]); and lastly, we may note that Binet and Henri[57] estimate that memory for connected sentences is approximately twenty-five times as good as memory for discrete terms.

Before examining critically the significance of the results which are outlined in the preceding pages, and discussing the exact nature of the material used in connection with the substance

[55] Ibid. p. 218

[56] " p. 217

[57] " p. 220

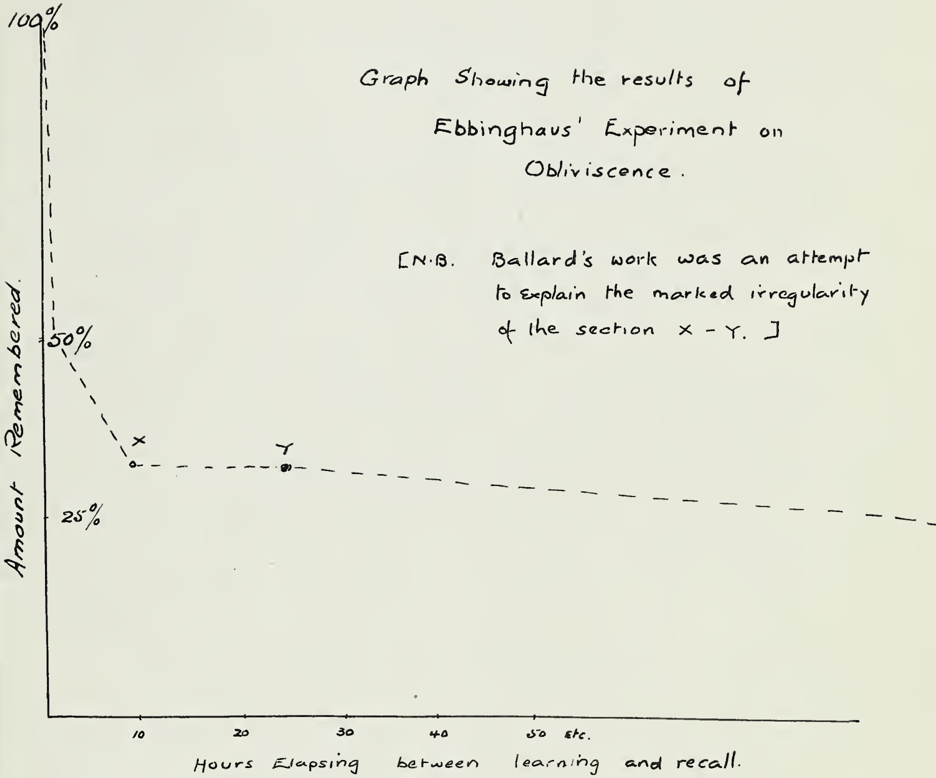
memory tests, there is one further interesting problem that is worthy of note, and which should lead to a great deal of further research. This is the general problem of obliviscence or forgetting, and the related phenomenon, reminiscence. Obliviscence, it is true, is usually regarded by teachers as a defect, although Ribot[58] has termed it a condition of memory, and Adams[58] states that true learning is really judicious forgetting.

The rate of forgetting was investigated by Ebbinghaus.[59] It was his purpose to determine how the process of forgetting would proceed when left merely to the influence of time; and he attempted to do this by means of series of nonsense syllables. He found that in the first hour after learning, almost one half was forgotten; nine hours after, two-thirds was forgotten. The same ratio between the remembered and forgotten obtained after twenty-four hours; and after six days about one fourth only was retained; while after a month, fully one fifth of the effect of the first learning persisted. The results are represented

[58] Quoted from Rusk, op. cit., p. 94

[59] 'Memory', English Trans., Chapter viii.

graphically on the accompanying diagram:



Graph Showing the results of Ebbinghaus' Experiment on Obliviscence.

[N.B. Ballard's work was an attempt to explain the marked irregularity of the section X - Y.]

The third and fourth values were regarded as unsatisfactory by Ebbinghaus, since there appeared to be practically no forgetting in the interval

elapsing between the ninth and the twenty-fourth hours. Ballard[60] undertook to explain this peculiarity, and disclosed the factor which he called 'reminiscence'. This factor he defines as 'a gradual process of improvement in the capacity to revive experiences'[60]. His experiments differed from those of Ebbinghaus, however, in two important respects. Whereas Ebbinghaus had used adults as subjects, Ballard's work was done mainly with children of school age. In the second place, while Ebbinghaus' Curve of Forgetting resulted from work done with nonsense syllables, Ballard's material was a well-known poem. (Cowper's "The Loss of the Royal George")

This diversity in the nature of the material is so marked, that the question is worthy of further discussion. And Ballard's experiment is indeed distinctly suggestive of further investigations. He found that, after giving a class of twelve-year-old boys in a London school, thirteen minutes in

---

[60] 'Obliviscence and Reminiscence', p.17. Cf. Rusk, op.cit., pp. 96-99

~~minutes~~ which to memorise the poem, only one boy could reproduce the whole of the thirty-six lines. The average number of lines for the class was 27.6. After two days, however, when, without warning, the class were asked to write out all remembered then, eight of the boys reproduced the whole poem correctly, and the average number of lines correct was 30.6, - an increase of more than 10 per cent over the previous number. Out of the nineteen boys, none had deteriorated, and sixteen had improved.[61]

Extending the investigations by using different types of poems, and with different intercalations of time between the primary and secondary reproductions, he found that the most favourable interval is two days. The improvement varies with age, but is greatest in young children, adults showing practically no improvement at all. It is interesting to note further, that where reminiscence was demonstrated, it was due not merely to the addition of lines not occurring in the primary reproduction of the poem,

---

[61] 'Obliviscence and Reminiscence,' p.2.

but that substitution of lines was taking place, some lines being added, others omitted.

The fact of reminiscence is not new, and was even recorded by Quintilian.[62] But it is undoubtedly worthy of further investigation. It would, for instance, be especially interesting to determine just how highly reminiscence correlates with general ability, or whether, as Ballard suggests,[63] it is more characteristic of undeveloped than of mature intelligence. The problem would have to be attacked not only with people of all ages as subjects, but with all kinds of sensible material, for undoubtedly the nature of the passage to be learned plays a large part in determining the amount of subsequent improvement in reproductive power. (This problem is treated more specifically on page 125).

The foregoing outline of past research in the field of memory is by no means exhaustive; but possibly sufficient has been said to meet the needs

[62] 'Institutes,' book xii, chap. ii. [Quoted from Rusk, op. cit., p. 96]

[63] 'Obliviscence and Reminiscence,' p. 43.

of this paper. The main aspects have been treated, in such a way as to indicate the general trend of the experimental paths which have been followed. At this stage we find ourselves enquiring seriously as to how much certain knowledge the results quoted above give us. It is true that some of the differences in development of the various forms of rote memory, for example, are significant to educationists; and these differences appear to be fairly well established. To cite one instance, the memory for numbers appears to develop simultaneously with the memory for abstract conceptions, and both develop relatively late. (The child's retentive power for number is greatest about the fifth or sixth year of his school life).[64] Such facts as these must be recognised by educationists, since they are valuable in interpreting certain situations which are constantly arising in school life. But a large number of past efforts seem to be characterised by a lack of systematic plan and consistency.

[64] Journ. of Educ. Psych. vol v. p.420. Cf. Rusk op. cit. p. 88.

It is possible that the cause of this lies partly in the conception of Memory itself, on which the methods of investigation naturally depend. The distinction between 'rote' and 'logical' memory has been accepted as quite definite, for a long time, and by Psychologists generally. Hence we are inclined to take that distinction for granted. Rote memory is regarded in the light of a habit, having an organic basis; 'logical' memory is usually explained in terms of psychic activity, meaning, consciousness, spirit, or some similar, intangible term. If we recognise the necessity for clinging to this distinction, then there is little that can be said against the general methods of attacking the experimental study of memory, at least as far as the theory, on which that study is based, is concerned. But if we admit the possibility of explaining 'logical' memory in terms of matter and of habit formation, as the Behaviourists suggest[65], then there is every reason to criticise and
? ? do-over much of the work that has been done up to the present, and to continue~~s~~ the investigations along comparatively new lines.

[65] Watson: 'Psychology from the Standpoint of a Behaviourist,' Chap. X., etc.

Let us first look at one or two of the old, - more firmly established, more conservative, conceptions. Perhaps the most brilliant work, from the point of view of literary achievement, and beauty of expression, is Bergson's "Matière et Mémoire". Expressed very briefly,-and therefore inadequately - the central core of his doctrine is as follows: "There are two memories which are profoundly distinct: the one, fixed in the organism, is nothing else but the complete set of intelligently constructed mechanisms which ensure the appropriate reply to the various possible demands. This memory enables us to adapt ourselves to the present situation; through it the actions to which we are subject prolong themselves into reactions that are sometimes accomplished, sometimes merely nascent, but always more or less appropriate. Habit rather than memory, it acts our past experience but does not call up its image. The other is the true memory. Co-extensive with consciousness it retains and ranges alongside of each

other all our states in the order in which they occur, leaving to each fact its place and consequently marking its date, truly moving in the past, and not, like the first, in an ever-renewed present".[66] "The past survives under two distinct forms: first, in motor mechanism, secondly in independent recollections".[67]

Bergson illustrates the former, by considering the learning of a lesson 'by heart'. "The memory of the lesson, which is remembered in the sense of learned by heart, has all the marks of a habit. Like a habit, it is acquired by the repetition of the same effort. Like a habit, it demands first a decomposition and then a recomposition of the whole action. Lastly, like every habitual bodily exercise, it is stored up in a mechanism which is set in motion as a whole by an initial impulse, in a closed system of automatic movements which succeed each other in the same order, and, together, take the same length of time."[68] The pure memory, he affirms, "records, in the form of memory-images, all the events of

[66] 'Matter and Memory', English Trans., p. 195.

[67] Ibid. p.87

[68] Ibid. pp. 89-90

our daily life as they occur in time; it neglects no detail; it leaves to each fact, to each gesture its place and date. Regardless of utility or of practical application, it stores up the past by the mere necessity of its own nature."[69]

For Bergson, these two forms of memory are quite distinct. The habit memory, or the 'useful memory',[70] has an organic basis, and belongs to the sphere of matter; the pure memory affirms the reality of spirit. Both, however, involve 'retention;' the reinstatement of a past scene as well as the reproduction of intellectual work previously learned, imply that both have been retained. With the child, both memories are implicated in one another, and it is only late in his development that he comes to dissociate the process of learning from the incidents accompanying the learning and is able to recall the lesson without the latter adhering; that is, to dissociate the habit memory from the pure memory, and thus attain to imageless memorising.(Bergson's

[69] Ibid. p. 92

[70] " p. 233

view is that the habit memory is imageless.)

McDougall[71] accepts the distinction made by Bergson, preferring the term 'meaning' to 'pure memory'. He says: "Of recent years a large number of exact experiments have been reported as investigations into memory. The experiments have in most cases consisted in committing to heart by repetition rows of words, letters, numbers, or more frequently nonsense syllables, series of syllables that convey no meaning; and in determining the laws of the association and reproduction of such series. Great refinement of method and nicety of results have been attained, and many important laws have been thus empirically established. One of the most striking of the results thus achieved is that the associations established by serial repetitions of this kind obey, in the main, in regard to their formation, operation, and decay, the laws of motor habit. It may be said, then, that here is substantial evidence justifying the identification of memory

[71] 'Body and Mind', Chap. xxiv.

with habit. But these experiments, though generally called investigations into memory, are so conducted that the factor of true memory hardly enters into the operations. They are in the main investigations of verbal habit; for there is no reason to doubt that such a process as the repetition of the alphabet is essentially the operation of a habit; and the investigations to which I refer have dealt almost exclusively with processes closely approximating to this type."[72]

Following very closely the arguments of Bergson, he says that true remembering is a process of a very different type; and he illustrates this with the ~~follow~~ example of a series of eight nonsense syllables, presented one by one by a mechanical arrangement. "After four repetitions of the reading, the first syllable alone is presented, and I attempt to say the series by heart and fail utterly.. ..Perhaps after twelve repetitions, I succeed in saying them by heart without a hitch; my

---

[72] 'Body and Mind', pp. 333-334

organs of speech seem to roll out the sounds, and all I have to do is to avoid anything that may interfere with the process; for, just as in executing any habitual series of manipulations with the hands, the process goes on best if left to itself. But now I can throw my mind back and can remember any one of the twelve readings more or less clearly as a unique event in my past history. I can remember perhaps that during the fifth reading I began to despair of ever learning the series, and that I made a new effort, that someone spoke in the adjoining room and disturbed me disagreeably; I may perhaps remember what he said."[73]

The principal differences between the retention of a series of nonsense syllables and the remembering of any one particular event or one of the readings of the series, are enumerated and discussed by McDougall.[74] He says that the repetition of nonsense syllables depends on the formation of a habit;.and each of the successive readings contributes

---

[73] Ibid. p. 334

[74] " p. 335

to the production of this habit. The remembering of any one of the readings of the series, on the other hand, depends wholly upon a single act of apprehension. The former involves a looking-forward attitude, while the latter is essentially retrospective; and while the smooth reproduction of the syllables is hindered rather than aided by any effort to cast back my thought to the moment of apprehension, the 'remembering' is aided by 'voluntary rumaging in the past'[75]. Finally, while the linking of the syllables in serial order necessitated concentration for some minutes, although the remembrance of any particular event may involve the reproduction of a vastly more complex set of sense-impressions made almost simultaneously, yet these are linked in a single act of apprehension.

His distinctions reduce themselves fundamentally to the fact that the nonsense syllables are practically meaningless, while the impressions 'truly remembered' convey a more or less rich meaning. This would be

[75] Ibid. p.335

very generally accepted in the psychological world; but unanimity of opinion does not exist because the conception of 'meaning' is by no means uniform. While we agree with McDougall's statement that meaning is a very important condition of reproduction,[76] or remembering, it is difficult for modern psychology to accept his view of meaning as having no physical parallel. (Meaning, he says, 'is a purely psychical product of psychical activity,'[77] and 'we cannot assume that it has any immediate physical correlate among the brain processes'.[78]) It is obvious that McDougall follows very closely the arguments of Bergson in emphasising the distinction between habit and true memories; but it is hardly conceivable that he accepts all the philosophic implications of Bergson's doctrine. If pure memory, as McDougall says, does not obey the laws of the physical world, then it is difficult to see how Psychology can adopt its strictly scientific attitude in this field. And if psychological research has to give way to metaphysical speculation here, a

---

[76] Ibid. p. 337
[77] " p. 311
[78] " p. 337

very large and important part of the field of applied psychology is cast beyond the pale of empirical study.

In attempting to criticise the position of McDougall, which is taken as typifying certain conceptions current in psychological literature, perhaps the best method of procedure is to outline an alternative solution to the problem, and then to use this in answering the main arguments which support the more speculative hypothesis. If we regard all memory as being explicable in terms of habit, we have a common basis which makes it possible to compare rote with logical memory. The main difference becomes one of complexity, refinement, organization, etc.--rather than a distinct difference of kind, involving organic phenomena on the one hand, and psychic phenomena on the other. 'Psychic' terms then become explicable in physical terms; and though this is equally speculative, it is a hypothesis which leads to a more concrete method of investigation, and to a more tangible standard by which to interpret results.

If I memorise a series of impressions, - for example, a short sentence, -'rote' memory certainly plays an important part. It may be the only factor, if the 'meaning' of the sentence is not grasped. But when we speak of 'meaning', we are not necessarily introducing a mysterious element which acts in some spiritual manner in assisting the process of habit memory.'Meaning'involves the utilization of past habits which have been built up in the organism. According as many or few of those habits have been formed, and according as they are utilised and brought to bear upon the present situation,or not, - so the richness of the 'meaning' varies. The same sentence, starting with impression A, and resulting finally in impression N, may be remembered by rote, or the words may, and usually do, possess a great deal of meaning, which aids the memory process considerably. If the series is memorised purely by rote, then impression A calls up B, and the series A,B,C,D,. . ..N, is quite fixed in, like any ordinary habit. If 'logical'memory is employed, then impression A, or

one of the ideas associated with A in the past, calls up one of the numerous associations with which B is linked; and so on with C, D, E, etc. The remembering in this way may involve many ideas, different from the impressions actually received in the original ~~presentations~~ presentation of the sentence; but so long as the result N is reached, the sentence is remembered. The extent to which meaning assists depends on two main factors: (a) the richness of the field of habits which the individual has acquired, - i.e. the amount of meaning that is actually present, and (b) the power to utilise these habits in relevant situations.

Purely rote memory, as actually utilised, is more of a curiosity, a pedagogical fancy, than a tool. To some extent it is employed by teachers in setting their pupils to memorise poems, etc., - although rote memory is not the only factor involved, since the meaning, the number of relevant past habits that are called upon to assist in making this

new habit useful and efficient, is an important element in the process. The learning of the alphabet in early life, is perhaps one of the few illustrations where meaning is comparatively absent; and this is possibly as good an example as we have of the 'habit memory', (using that term in the sense in which it is used by McDougall,) in universal practise. It is quite conceivable that memorising such a series of independent units, for the first time at least, might be performed without any complex factor entering in. But in practise, this is not as true as would at first appear; for, with each individual letter, numerous associations have been built up before the alphabet as a whole is taught. And after having learned the alphabet, each subsequent repetition enhances the rhythmic effects; the visual, auditory and kinaesthetic images become more and more important, as well as the increasing recognition of each letter as a part of a whole, which undoubtedly has a very definite meaning attached to it.

Again, any formula may be learned by rote. We may succeed in remembering that the area of a circle is πr^2, or that the sum to infinity of a series in Geometric Progression, is $\frac{a}{1 - r}$; but these are useless until they are linked by other habits to factors which make them useful, - i.e. until logical memory functions also. Similarly with words, language, the vocabulary of a foreign language, etc., - the larger ~~greater~~ the number of memory habits built up in connection with each word, formula, or phrase, the greater, the richer, the meaning, and the more efficient the bases of memory will be.

In this connection we note that our teaching methods would, in general, support this thesis. Our aim is to build up as many of these relevant habits as possible; in other words, to make the meaning richer. We avoid purely rote memory as much as possible. When Thorndike[79] says that in teaching the 'division by fractions', we are justified in instructing the class to learn the rule, - 'turn the fraction

---

[79] 'The Psychology of Arithmetic', p. 154

upside down and multiply' - by rote, and let the significance of the procedure come later, he is advocating a very dangerous policy. Too much of our study 'for examination purposes' is of this type. We learn a great deal of material with as little aid from associated habits as possible, - i.e. we memorise often without understanding the meaning adequately. The Freshman, in his first year Biology course, must do this in order to satisfy the examiners. He fully intends, so he says, to supplement those rote memory paths later, by establishing bonds which amplify the meaning. But the habit of using rote memory wherever it will serve, with as little logical memory as possible, very often persists, and is itself fixed in more and more as he proceeds with his course. When he leaves the University, many of these rote habits die or fade through disuse. If however there ~~are~~ is a large number of associated habits, there is a much greater chance that these pieces of information which are encountered during

university days will be used, the habits will be more firmly fixed, and hence there will be less likelihood of forgetting.

This conception of meaning is, of course, fundamentally Behaviouristic. It has the advantage over the other type of theory, that it gives a tangible basis of procedure. The conception of meaning as psychic, - using that term in its generally accepted sense,- is not conducive to further empirical investigation. Starting with this as a preliminary hypothesis, which is physically correlated, many further implications arise, which are of an interesting nature.

All memory involves rote memory, - but the fixing in of any material by rote is accompanied by a utilisation of past 'rote' habits. Hence in ordinary life, our memory is not purely rote in the old sense, i.e. it is always assisted by the old habits which give the new idea meaning; and according as ~~h~~ these habits are numerous and available, so is the meaning rich, and the memory process assisted.

Ability in memory therefore depends on the ease with which these habits are formed, and secondly on the ease with which they can be brought to bear on relevant situations. The first depends on such factors as organic plasticity or lack of resistance to the force which establishes the habit-path. The second depends on a factor which makes the conception of logical memory appear very closely related to, if not identical with, intelligence.

We regard intelligence as the ability to use past experience in present situations. Such ability is usually classified as being on the level of organic memory,(bodily habit),or, in the higher form, as involving representation. The latter would appear to be a more complex form of organic memory, - not a process different in kind. Adjustments are made by intelligent beings more efficiently, more readily, more economically, because past experience has left its mark more

surely; and because the individual is better able to discriminate, i.e. to use the habits which are relevant, he is more intelligent. Discrimination is in reality a more delicate form of memory. Certain details, - that is, habits feebly fixed in ordinary persons, or perhaps not formed at all, appeal strongly to the person of higher intelligence. He does not miss or pass over any of these minor results of past situations which were in some degree similar to the present. This power to use the past does not depend on a psychic force, e.g. the amount of the élan vital present,[80] but on the fact that certain details have left their mark more effectively, and hence tend to be used in re-organising a new situation with similar elements.

The effectiveness of these habits will vary greatly in different individuals, and in the same person from time to time. Health, fatigue, nervous condition, etc., will, and do, affect the power of reaction to stimuli (internal as well as external), and retentiveness. Such variables as exist need not concern us, - the laws which govern

[80] Cf. Bergson. 'Creative Evolution.'

them belong specifically to other sciences. It may be that the plasticity of the organism is one factor, which however is related to the nervous system in a way analogous to the relation that is expressed by Ohm's law in Physics. Ohm's law states that the Current Strength, expressed in terms of the amount of work it can do, is equal to the Electro-motive Force divided by the Resistance. The latter term is analogous to our term 'plasticity', in a negative sense. The Electro-motive force may have a corresponding factor in the nervous system; so that the strength of the nervous current, - nervous energy being considered in terms of electrical energy,- depends on those two factors according to a definite law. And the strength of the nervous current, of course, means its power to leave its impress on the organism,- i.e. to establish a habit-path. Such hypotheses based on metabolic differences in individuals, are not new to Psychological literature. (Cf. Ribot's[81]

---

[81] 'Psychologie de l'attention'.

notions of the amount of blood passing over the brain, etc.) We are not really concerned with them, although it is highly probable that such laws will be discovered at some future date.

It is difficult to resist the temptation to wander off into a philosophic discussion of the implications of such a theory. Such a diversion is not possible here; but we would point out that the philosophic conclusions do not really affect us at this stage. Materialistic as this conception of memory, intelligence, thought, etc. undoubtedly is, on the surface, it matters little for practical purposes whether we conceive of the world of matter in terms of energy, spirit, vital force, or in any other terms. The fact that the ~~new~~ recent discoveries in connection with atomic structure appear in many respects to be leading to a non-materialistic conception of the universe, does not mean that Physics and Chemistry are being discarded. Psychology is an established science, and as such it leaves

metaphysical discussions as much as possible to the realm of Philosophy, whence it emerged.

The 'single act of apprehension'[82], - as McDougall terms the remembering of any one of the readings of the series of nonsense syllables - which is unique and distinct, is retrospective, and is made more vivid by 'voluntary rumaging in the past'[82] - consists , McDougall admits, of the reproduction of a very complex set of sense-impressions made simultaneously, or within a period of two or three seconds. There appears to be nothing in such a statement which is not in accord with the foregoing explanation of all memory in terms of habit. 'The remembrance of the particular event, though it seems to become less vivid and trustworthy, may be effected after indefinitely long intervals'.[83] This is readily explained by the fact that 'rumaging in the past' is merely another way of saying that we use those habits which were formed at that time. A large number of these habits ~~are~~ is being formed every minute of our lives. If we repeat these in our 'rumaging', it is quite in accordance with the laws

---

[82] 'Body and Mind', p335

[83] Ibid. p.336.

of habit that they should become more clearly defined; and even after a considerable period of disuse, the stimulation of any one, may and will cause similar stimulation of other paths connected therewith. When we speak of time, of looking forward, of retrospection, etc., we are using a habitual mode of thought. The retrospective nature of Bergson's 'pure memory', and of McDougall's 'meaning', is another phrase for our 'utilization of past habits'. The conception of Time itself is a habit. We are using it so constantly that its force is very marked. But it is none the less a habit, just as is our idea of space.

A few of McDougall's illustrative examples will perhaps assist in clarifying the present contention. He contrasts the ease with which a sensible passage of twenty syllables can be learned after a single reading, while twenty nonsense syllables would take, say, one hundred repetitions.[84] The difference is due to the fact that the sensible material is

---

[84] Ibid. p. 336.

synthesised by the meaning. That, of course, is true without question. But there is nothing here which does not agree with the foregoing statement. The ease with which we can memorise the sentence depends on the richness of our past habits, and the power of linking them with the present. Learning the nonsense syllables involves the formation of a path which is almost entirely new, with comparatively little assistance from the habits already possessed.

The example of the visualization of complex scenes is interesting, too. He says[85] that if he is required to draw a map of a series of dots shown on a screen for a fraction of a second, he finds great difficulty if the dots are irregularly arranged. Yet if they are in some series of geometrical shapes, the task is simple. This clearly exemplifies the 'habit' method of all learning. If we ask why a series of dots arranged in the form of a circle can be more readily grasped than a series of an irregular shape,

[85] Ibid. pp. 337-8

it is obvious that the answer lies in 'habit'. McDougall uses the term 'meaning' here; and unless we fall back upon a doctrine such as Plato's theory of Reminiscence, we seem forced to conclude that the 'meaning' of the circle exists, due to a habit formed in the past.~~li~~

His illustration of the photograph is likewise apt from our point of view. He says:[86] "My eye rests for a moment on a photograph or drawing of a striking face that is unknown to me. The drawing consists of a great number of points, lines, and areas, arranged in an extremely complex fashion; yet after that brief glance I am able to picture the face with considerable accuracy, perhaps even after the lapse of days or months; or I am able to single it out from among a large number of similar drawings, and my capacity to do this is not appreciably affected by considerable changes in the distance of the drawing from my eyes; yet with every change of distance the retinal points stimulated

[86] Ibid p. 338

are widely different."

Considering the complexity of the~~s~~ spatial relations involved in this task, and the rapidity and certainty with which it is accomplished, he says that it is not plausible to attempt to explain this remembrance as dependent on a material disposition, formed after the pattern of a habit. We first note, however, that he spaeks of a 'striking' face, not seen before, The fact that it is striking, means that the features are arranged in some manner that is either unusual, or else similar to some previously received impression which survives in a very definite way. 'Unusualness' is a very common factor which affects the relative strength of stimuli; and interpretation of faces is very clearly a popular and universal habit. In saying that he can remember the face, we add that it is not always easy to determine the accuracy of the image he calls up; or to be certain that the face he remembers from that one presentation is not really due to a series

of presentations of faces which are similar either in form, or in ~~p~~ facial expressions. Further, a striking feature is not nearly so complex as he would have us believe. Caricature artists would agree that it takes comparatively few lines to make one face, - a 'generic face'[87], to use McDougall's expression,- into a likeness of Mr. Asquith, or into a recognisable representation of Mr Lloyd George, for purposes of "Punch". Contempt, elation, misery, hatred, etc. can likewise be strikingly expressed on the generic face in a comparatively easy manner.

On this basis, the relation between immediate and ~~prolonged~~ delayed reproduction would serve as an experimental method of determining the soundness of such a hypothesis. Whether we investigate the verbatim reproduction of sense material learned, or the reproduction of the substance of the passage, it seems logical to suppose that the results would be the same. The subject who learns

---

[87] Ibid. p.339.

quickly, is able to do so because of the favourable organic factors mentioned before, or because of the richness of his available habits. Both factors operate, whether we are considering rote or logical memory; with rote memory, however, the former possibly plays the more important part, while logical memory is more dependent on the latter. But Since the factors themselves are inter-dependent, this latter statement is true only in a general way. The rapid learner will more probably reinforce the memory habits which he has built up, by repetition, since the relevant habits are more numerous, and therefore the tendency for some or all of them to be repeated will be greater. Much depends, however, on the type of material used in such an investigation. With material which was of such a nature that, through lack of meaning or absence of interest, the tendency to 'go over' the memory-paths was small, then the rapid learner might prove to be the rapid forgetter, since plasticity

of the organism would be the predominant factor. There is, of course, the possibility that the slow learner may, in some cases, prove to be the most retentive, because of the fact that he has, through the medium of well-directed teaching, built up a very extensive field of memory habits But the chances of such cases occurring frequently, are fewer, since, other things being equal, the individual who is handicapped by adverse organic factors will not form so many habits as his more fortunate neighbour.

In attempting to account for'Reminiscence' as defined and experienced by Ballard (page 29), our first contention would be that the phenomenon has not yet been definitely isolated. It would seem however, that a parallel exists between such a process, and the somewhat mysterious conception which is found in the popular statement: "We learn to skate in summer and to swim in winter",-Further investigation is necessary before anything definite

can be said on this matter; but it is probable that any actual improvement in a memory, after that memory has been established, will be accounted for along the lines of the Behaviouristic explanation of processes which take place during periods of no practice.[88]

The testing and training of memory from this point of view become more clear. As regards training, we would say that the rote side of memory, - the ability to build up habits, - cannot be changed. It depends on those organic factors which constitute~~s~~ the fundamental nature of the individual. Training in memory, however, would consist in establishing the habit of utilising all elements of past experience that can be made available. Teaching and examination methods should be of such a nature as to make it practically impossible to rely upon rote memory. This policy is adopted with success at Oxford, where emphasis is laid on the examination system,

[88] Cf. Watson, op. cit., pp. 301-302

and parrot-like repetition is eliminated as far as possible, by making the examinations exhaustive. To meet such requirements obviously needs the bringing into play of all possible past habits.

(Material suitable for memory training will be discussed later. - Page 127).

In testing memory, we would contend that the use of nonsense syllables is not satisfactory. In order to test that basic capacity for the formation of memory habits, - i.e. pure rote memory, it is indeed difficult to suggest material that would be suitable. Meaning must be absent as much as possible. But since it is obviously impossible to exclude entirely the element of meaning, it would appear advisable to make that meaning as constant as possible. Nonsense syllables, we admit, convey perhaps a minimum of meaning. But as we shall see later, their meaning is by no means the same for different individuals.

The main reasons for advocating the use of nonsense syllables are that the material can be made of uniform quality, can be manufactured to an unlimited extent, can be assembled in quantities of any desired length, and affords units which are comparable in difficulty.[89] Further, Pohlmann[90] contends that on account of the relative freedom from varying associations in different subjects, nonsense syllables formed the best and most reliable material for memory tests. In this connection we may quote Watt:[91] "Of all material proposed, the one which most resembles the kind of thing we have to make an effort to remember in daily life is the nonsense syllable. It can always be of the same length, and can be constructed according to fixed rules, based on the experimental results obtained by using syllables constructed in various ways. By the use of such syllables, of which great numbers can be made, the very disturbing influence of the

[89] Cf. Meumann: 'The Psychology of Learning', English Trans. pp 160-164

[90] Whipple, op. cit., p.153.

[91] H.J. Watt: 'The Economy and Training of Memory', p.12

"the meaning of words with their manifold associations can be eliminated from the experiments. It is a familiar fact that words whose meanings are known, are remembered more or less easily for all manner of reasons. Nonsense syllables, having no meaning, provide little attraction to the memory, because they are almost devoid of associations."

The claim that nonsense syllables are very suited to memory investigations because they are devoid of previously formed associations, may be challenged in many ways. One has only to attempt to construct these 'meaningless syllables' to discover how very difficult, - one might say impossible - it is to avoid the element of meaning entering in. However 'meaningless' the syllable, there will inevitably be some association factor entering, for some of the subjects being tested, if not for all. Take, for example, such syllables as:

Leb, rit, mon, yup, kig, des, wer, zam.

Bax, goul, fos, hiv, ped, vaub, jum, cor.[92]

Undoubtedly any one of these syllables calls up some

[92] Taken from Watt, op.cit., p.12.

associations, and some of them call up many more than others. Further, the units which are more readily associated, and hence more easily remembered, vary with different people. Certain mechanical factors also must be considered. The visualiser will attend to consonants more than vowels because the varying lengths of the former are more attractive to the eye. The audile, on the other hand, attends more to the vowels. Such being the case, it is clear that the series are not uniform in quality, and the units are not comparable in difficulty, as is claimed by those who advocate their use.

The popularity of nonsense syllables, however, is so great that we are forced to explain this objection to them at greater length. McDougall[93] condemns the use of such material because the syllables are devoid of meaning and hence, he says, they are unsuited to investigations of memory. We have already considered briefly his conception of memory and meaning; but in this connection we

[93]. op. cit. p.334

quote from a footnote to the passage referred to on pages 37 and 38: "The reason alleged for the choice of nonsense syllables ... is that they are devoid of previously formed associations. Really they are devoid of meaning, and to regard them as differing from words only in that they are devoid of associations, is to assume that meaning is nothing but a number of mechanical associations or reproduction-tendencies. This is the unjustified assumption which underlies the description of such experiments as investigations into the laws of memory."[93]

We have already criticised nonsense syllables because they are not meaningless, and will therefore not test pure rote memory. If we accept McDougall's view that they are meaningless, we would have to admit that for purposes of testing the capacity for establishing these rote habits, they would serve. But even so, a further criticism might be advanced, against past investigations which have involved their use.

[93] Ibid. p.334 footnote.

If we accept without question the laws which have been discovered by using nonsense syllables, (e.g. Ebbinghaus' Curve of Forgetting) and apply them in our ordinary life experiences, we are assuming that there is a parallel between such a process as the building up of a habit of rote memory, and the memory activities of a normal person. As already stated, the mechanical element, which undoubtedly is stressed in the case of nonsense syllables, is always present ~~and~~ to some extent in all memory activities. But the memory process is more complex, and in investigating it, we are not investigating the operation or mechanics of a simple habit. When we have discovered the laws which govern the memory of nonsense syllables, we are not qualified to pass judgment on the really vital questions which are so numerous in the field of memory, and which are so important from the standpoint of pure Psychology, as well as for the applied psychologist, be he educationist in the common or in the broader sense of the term. Hence if we regard nonsense

syllables as meaningless, we ask what parallel is there between experiments which have been conducted with them, and ordinary memory pursuits, since the mechanical memory of material absolutely devoid of meaning is seldom or never used ? Does the 'Curve of Forgetting', for example, apply to the many kinds of sensible material ?

But if we accept the fact that nonsense syllables have manifold associations, which give them a very definite meaning, it seems that they have very little advantage over ordinary sensible material. The latter can be definitely classified, as for example, the classification used in the experiments on the special memories. The words 'book', 'pen', etc., although they may call up associations which differ to some extent with different individuals, have nevertheless a core of meaning which is constant. The associations centre around a certain definite concept which is denoted by the word. Especially is this true

with children, those associations are not so varied as those of adults. But if we use a nonsense syllable e.g. 'mon',[94] we may say that it has very little meaning; yet the interpretation of that syllable by a French~~man~~ student, would be decidedly different from that by a Scotchman. To some, it would be a nonsense syllable, but to others it would be full of meaning, - the meaning varying in every case, depending on past experience.

In whatever light we regard nonsense syllables, then, - whether as having meaning of a varied nature, or as being meaningless, the advisability of their use is questionable. From our point of view, in testing the ability of a child to memorise by rote, we would advocate the use of sense words rather than nonsense syllables, for the reasons stated above, viz. (a) words can be classified in some manner, so that the meaning which they give can be of a similar type, e.g. objects, involving space relations, abstract words, involving finer

[94] Cf. the series quoted on P. 64

and more complex habits, etc., and so make the meaning core as definite as possible; (b) the core of meaning is more constant in the case of sense words, especially with younger children.

Letters could be criticised for reasons similar to those which obtain in the case of nonsense syllables. Although they appear to be meaningless when considered superficially, early training almost invariably leads to a great variety of meanings being attributed to them. With digits, however, it is not usual to build up as many associations as with letters. In teaching the alphabet, all kinds of devices are used. With numbers, this is not so generally true. Perhaps digits would be as near the ideal meaningless material for testing that innate organic plasticity as we can hope to obtain - although none of this material is absolutely ideal. It is interesting to note with reference to our contention that memory and intelligence are closely linked,

that intelligence tests frequently use digits, in testing this plasticity which is a basic factor both in intelligence and in memory.

The use of objects, pictures, drawings, sounds, etc is likewise a questionable method of attacking the study of memory, since we are not thereby investigating the rote capacity isolated from previously formed memory habits, nor are we testing those functions which operate most frequently in every-day life. Since the organic factors are more or less constant throughout life, and since they can be but little, improved, (if at all), our most logical policy would seem to be to concentrate upon that phase of the study which is of more vital significance to all branches of education. The memory for isolated words, letters, etc., is not nearly so important as the memory for the significance which those words possess in relation to others. Language does not consist of a series of isolated, discrete, impressions, but of a system of verbal habits

which are inter-related in a very complex manner. Consequently we would advocate that emphasis be placed on sensible passages, - tests of 'logical memory', rather than on the somewhat doubtful process of memorising isolated units.

Before discussing in greater detail the exact nature of the material that appears to be more suited to investigations of this type, however, there is one further problem that runs parallel to ~~the~~ the whole question of material, namely, the problem of methods of memorising. It is generally accepted in educational circles that emphasis has been placed in the past on methods of teaching, but that the modern tendency is to stress methods of learning. The two must necessarily be considered in relation to each other, since they are both dependent on the psychological understanding of the pupil. However efficient the teaching methods may be, it is futile to expect the child to adopt the most economical and the best methods of learning without guidance

Meumann says:[95] "Memorisation should not be a matter of accidental success as it has been in the past; nor should it be given over to the blundering efforts and the unsystematic groping of the child. It should not entail ~~a~~ the waste of time and of energy which necessarily results from a desultory and fortuitous procedure. The teacher must raise it to a higher plane; and this he can do by directing his pupils in their process of learning and by adapting their activity to conform with the results obtained from investigations of the conditions of economical learning"

At present, the superiority of the 'Entire' method over the 'Part' method is generally acknowledged. According to the entire method one learns by repeating the material right through from beginning to end. With the part or sectional method, on the other hand, the material is divided into sections, - for example, verses of a poem; each section is memorised independently, and then all the sections are connected. The reasons generally given to account for the superiority of the former method, are: (a) The attention is more uniformly sustained in the entire method, since new material is

---

[95] 'Psychology of Learning', English Trans., p 336

continually being presented as we pass from beginning to end. (b) In the sectional method, there is a tendency to repeat the first sections more often than the succeeding, whereas with the entire method this uneven distribution of repetitions is avoided. (c) No redundant associations are formed in ~~in~~ entire learning, e.g between the last word of the section and the first word of the same section. (d) By the entire method, the material is impressed on the mind as a whole, and hence the sense of the passage affords some assistance in learning.[96]

Two main objections have been raised, however, to the use of the entire method. In the first place, sections already memorised are repeated, until the more difficult sections are memorised; and secondly, the middle part of the passage usually suffers because the attention is greater towards the beginning and the end. Hence we find the 'Mixed' method seeking to avoid the defects of the others, and to secure their advantages. This method requires that the material should be divided into

[96] Cf. Rusk, op. cit., pp 204-205
and Watt, op. cit., pp. 48-53

sections, and that after each section a pause should be introduced in the reading; the principle of entire learning is nevertheless followed, as the individual reads through continuously from beginning to end. With this method, attention is not so liable to fatigue, as with entire learning, and the weakness of associations in the middle sections is thereby avoided. If a difficult section occurs, this can after a suitable pause be attacked with renewed attention, and if the section is not immediately repeated, no unnecessary associations are formed. When great irregularities in the material occur, the entire method might first be adopted, until the learner becomes conscious of the definite parts which are specially difficult; these should then be learned separately, after which the entire method should be ~~returned~~ again adopted.

Neumann[97] claims that the method which is most suitable, depends upon the grade of endowment which the child possesses, - the entire method

---

[97] Günther Neumann: Zeitschrift für die experimentelle Pädagogik, vol iv [Quoted from Rusk, op. cit., p. 205]

being distinctly advantageous in the case of highly intelligent pupils. Meumann contends that the mixed method is most favourable for immediate reproduction, and that for retention the entire and mixed methods are of equal value.[98] Many other opinions have been expressed, since the problem is by no means new. (We find that Quintilian offers a theoretical solution.[99]) But unanimity is hardly to be expected, since the nature of the material employed has not been seriously considered. Nonsense syllables, and sensible passages of varied content have formed the basis of such experiments. So that a justifiable assumption is that a more explicit classification of sensible material might assist us in determining which method should be used to advantage in any particular case.

In the same connection we find lack of agreement with reference to the maximum length of material which can be conveniently handled by the entire method. The most suitable distribution of repetitions, (a problem attacked by Ebbinghaus with nonsense material[100]), and other allied problems, must, it seems, depend to some extent on the content

[98] Vorlesungen, vol iii p. 98 [Rusk op. cit. p. 206]
[99] 'Institutes,' book xii, Chap. ii "
[100] 'Memory', Engl. Trans. p. 89

of the passage being learned. And it is also quite probable that the distribution of the material itself is a very significant factor in all memory work.(Cf, the suggested problem on page 120).

The fundamental contention which this paper seeks to establish, and for which purpose the experimental work here reported was undertaken, may now be expressed more specifically. We claim on a priori grounds that more emphasis should be placed on sensible material, as stated earlier, since the complex memory processes of the normal individual appear to be more closely allied to such tests as involve the remembering of inter-related ideas, rather than to the memory for isolated impressions. Our next contention is that the many problems which confront us in the field of memory may possibly be more easily solved if we study carefully the reactions of individuals to passages of sensible material of a distinct and homogeneous type.

To illustrate this second contention, - we might suspect on a priori grounds, that the sectional method~~s~~ would give the best results with sensible material of a certain kind. Difficulties that arise when memorising is being done by the entire method, might be overcome if we found that for certain people, one type of sensible material offered especial difficulty. Or, to sum up the essential feature of this work, the variation in the nature of the results of past experiments may be due to the fact that the many types of sensible material that are commonly encountered, are indeed distinct; and hence more attention must be paid to the exact nature of the material employed, as well as to the other objctive conditions which are generally recognised.

We have seen how, in the experiments on the 'special memories', the material was subdivided in such a way as to show marked individual differences in respect to these memories. If we use a similar procedure, substituting sensible prose for series of discrete impressions, it is highly probable that

our quest will be simplified, provided that the material be made as homogeneous as possible.

If we examine one or two passages which have been used in former investigations of 'logical memory', the need for this classification becomes evident. The following selection, "The Marble Statue", was used by Shaw and Pyle in their studies of memory with school children:[101]

The Marble Statue.

(166 words, 67 ideas)

A young |man| worked| years| to carve| a white| marble| statue| of a beautiful| girl.| She grew prettier| day by day.| He began to love the statue| so well that| one day| he said to it:| "I would give| everything| in the world| if you would be alive| and be my wife.|" Just then| the clock struck| twelve,| and the cold| stone began to grow warm,| cheeks red,| the hair brown,| the lips to move.| She stepped down,| and he had his wish.| They lived happily| together| for years,| and three| beautiful7| children| were born.

---

[101] Whipple, op. cit., p.209.

One day he was very tired, and grew so angry, without cause, that he struck her. She wept, kissed each child and her husband, stepped back upon the pedestal, and slowly grew cold, pale and stiff, closed her eyes, and when the clock struck midnight she was a statue of pure white marble as she had been years before, and could not hear the sobs of her husband and children.

For purposes of comparison, the following passage, used by Whipple, is here reproduced:[102]

Cicero.

(125 words, 64 ideas)

Cicero, the greatest of the Roman orators, was born at Arpinum, an obscure country town. His family was of the middle class only, and without wealth, yet he rose rapidly through the ranks of Roman official service until at the age of forty-six he became consul. In oratory he is by universal consent placed side by side with Demosthenes, or

---

[102] Whipple, op. cit. p. 209

at least | close after him. | He surpassed | the great | Attic | orator | in brilliancy | and variety, | but lacked | his moral | earnestness, | and consequent | impressiveness. | He could be | humourous, | sarcastic, | pathetic, | ironical, | satirical, | and when he was malignant, | his mouth was | most foul | and his bite | most | venomous. | His delivery | was impassioned | and fiery, | his voice | strong, | full, | and sweet, | his figure | tall, | graceful | and impressive. |

The same investigator employed the following passage as well:[103]

The Dutch Homestead

(180 words, 94 ideas)

It was | one | of those spacious | farm | houses, | with high | ridged | but lowly | sloping | roofs, | built | in the style | handed down from | the first | Dutch | settlers, the low | projecting | eaves | forming | a piazza | along the front | capable | of being closed up | in bad weather. | Under this | were hung | flails, | harness, | various | utensils | of husbandry, | and nets | for fishing | in the neighbouring

---

[103]. Ibid. p.210

river. | Benches | were built | along the side | for summer use; | and a great | spinning wheel | at one end, | and a churn | at the other, | showed | the various | uses | to which this | important | porch | might be devoted. | From this piazza | one might enter | the hall, | which formed | the centre | of the mansion | and the usual | place of residence. | Here | rows | of resplendent | pewter | ranged | on a long | dresser | dazzled | the eyes. | In one corner | stood a huge | bag | of wool, | ready | to be spun; | in another | a quantity | of linsey-woolsey, | just | from the loom; | ears | of Indian | corn | and strings | of dried | apples | and peaches | hung | in gay | festoons | along the walls, | mingled | with the gaud | of red peppers. |

There is almost as much difference between these passages, selected to measure the 'substance memory' as between nonsense syllables and "The Loss of the Royal George". The first passage involves ideas of various types. It has elements of narrative or temporal relation, is very well sprinkled with emotional terms, and contains also a number of images of various kinds. The second selection is largely

of a temporal nature, with elements of logic and emotion also present; while the third, is almost entirely spacial in nature, with one or two vivid images added. More striking examples could be found, but these are selected because of the fact that they have been used by several different investigators.

In school and college work, the student is called upon to learn material which is very varied indeed. Certain phases of the work give difficulty, and naturally individual differences are very marked. It seems reasonable to suppose that a careful analysis of sensible material into as many distinct elements as possible, would enable us to discover these individual difficulties. We would then be in a better position to advise as to the best methods of work, the places where emphasis is needed, and, conceivably, to diagnose a student's special abilities and vocational dispositions.

As to the number of subdivisions which can be made, it is dangerous at present to give any

any final pronouncement. But as a starting point along these lines, four clearly defined types of passages were selected, under the headings: (a) Spatial matter, or description- passages containing ideas related spatially; (b) Temporal matter or narrative - in which the ideas are related in a time series; (c) Passages of sensous content, - imagery,- in which the various types of images are found; (d) Logical passages, - using the term 'logical' in a sense decidedly more narrow than that in which former investigators have done. Instead of including all types of sensible material under this term, we are limiting its application to passages of logical argument, involving a continuous train of reasoning.

Each of these types may be subdivided; and many cinditions enter in which make it possible to secure passages of spatial material, for instance by no means equl in difficulty. Many of these variables were suggested by the experimental work here

described. Others would undoubtedly be discovered upon further investigation. But the starting point of our procedure was that there is a marked difference between descriptive material and logical or temporal; and that if notable individual differences could be discovered in respect to these general types, then perhaps such a discovery would lead to the solution of many further problems which have not so far been solved, and some of which have not yet been isolated. It was also thought to be more advantageous to test a student's power of grasping space relations, for example, in a passage of prose where such relations were specifically involved, than to experiment with such isolated units as e.g. geometrical figures.

The passages employed were selected , (one of each of the above types) from works of standard authors, such as would be commonly met in school work. The first difficulty in such a selection was, of course, that it is not always easy to find

passages of suitable length containing ideas of the one kind. Naturally in the same paragraph, one frequently finds material belonging to several types. But it is comparatively easy to distinguish such passages as were eventually chosen, since the difference in content is quite distinct. As will be pointed out later, should a passage which is selected for, say, its spatial content contain a few ideas related temporally or logically, the method of scoring may readily be adjusted to allow for this. But in the present instance, no such adjustment was necessary.

After selecting the passages, they were adjusted to a length suited to the time available for learning, and to the calibre of the students being employed as subjects. In order to do this, each passage was given to a small group, under conditions similar to those which obtained in the case of the experiment proper. It was thus an easy task to arrange the length of each selection so that it could be mastered by a normal person

in a class period of any hour. About twenty seven or twenty eight ideas was a convenient number, although, of course, certain other factors, such as nature of material etc., enter here. It was also deemed advisable to arrange the passages so that the number of very unusual names would not be great and would be about equal in each passage.

The experimental method was as follows. The subjects were members of a class in Psychology in the University of Alberta. Dr. J. A. MacDonald, who was lecturing to this class, and under whose direction this work was done, was the only experimenter. So that variations in results due to slight differences in procedure were entirely avoided. Further, the details of procedure were so arranged that such variations would not occur even if different experimenters were in charge, if the instructions were followed carefully.

The nature of the class was such that the co-operation of the members was readily secured.

Being students of Psychology, the experiment was one which interested them from the point of view of the study itself, as well as from the personal standpoint. The objects of the investigation were explained to them, and the necessity for following the instructions was duly impressed upon them. In these respects, the conditions could not have been more satisfactory.

The passages of spatial, temporal, imagery and logical content were treated on different days. Each student was given a copy of the passage to be learned, after the procedure to be followed was clearly understood. Their instructions were, to read the passage through carefully once, from beginning to end, reproducing on a blank sheet of paper all that they could after just one reading. They understood that it made no difference to their class standing if they could reproduce nothing. In the process of reading the passage, under no conditions must they go back and re-read any one section of it. A 'reading' consisted of reading

the whole passage once, with no repetition of any phrase or name contained in it, whatever. When they had~~e~~ reproduced all that they could after the first reading, the reproduction was covered, and not referred to again. Each student, in his own time, then proceded in a similar manner to read the passage a second time, and reproduce all that he could afterwards. Reproduction number two was likewise covered, and the passage was read a third time. This continued until they had learned the whole , or until they could learn no more. They understood of course, that the ideas contained in the passage need not be reproduced verbatim, but simply in the correct sequence. No attempt was made to underline words reproduced which were the same as those in the original passage, as was the case with Whipple's experiments with sensible prose.

The students themselves marked their own individual results. This again was quite possible with a class of this type. The instructions were

definite, and the system of marking was such that the results were accurate. Each passage was divided into 'ideas', as indicated in the actual passages used, which are appended. (Appendix I, pp.i - xiv.) The process of dividing such material into 'ideas', is quite familiar to experimenters with sensible material. It is even more easily performed in the present case, since the ideas in each passage are related in a definite and constant way. An'idea' is a word or phrase which constitutes an element in the passage, which is distinct, necessary to the content, and not divisible into further elements. Naturally the ideas in the different passages are of such a nature that their relation to each other is distinct. The results were calculated in percentages of the total number of ideas, and were graphed against the number of repetitions.(See Appendix II, pp.xvii - xli.)

After a period of two weeks, - which was sufficiently long to enable the effect of recency of one

type of passage to have become negligible, - the students were asked, without warning, to reproduce what they could of each passage in turn. No one had expected this, and access to the passages was not possible during the interval, in any case. A few days later, a passage of nonsense syllables was learned similarly, with a view to determining, (in case any very great differences of ability in learning one of the sensible passages was observed), if this type of material showed any marked significance. Finally, the students added any points of interest brought out by introspection. Some of these proved to be very suggestive, as will be shown later.

In the case of the Imagery passages, - by which is meant prose material containing very vivid images of all kinds, - it was ~~the~~ discovered that an unsuitable choice had been made, since the images were largely of the visual type. (Imagery Passage Number I, Appendix I, p i) There was not sufficient variation to warrant the inclusion of the data obtained in the final results. When

another passage,(Imagery Passage Number II, Appendix I p iii,) was used, which overcame this difficulty, the nature of the scene was so familiar that its results were discarded also. The students said that, although they did not remember reading that identical selection, (this particular passage was composed for the purpose,) yet they had pictured to themselves, hundreds of times, scenes of that nature. Consequently lack of time necessitated that work with this very interesting and important branch of sensible material be postponed until a later date.

In the case of the Spatial material, the first passage, (Spatial Passage Number I, Appendix I p v) included very familiar objects in a very limited, compact group, - the interior of a room. The second passage, however, (Appendix I p vi) gave a much greater range from the standpoint of space, and was chosen finally as more suitable for present purposes, since it was more in keeping with the nature of the Temporal passage. Nevertheless the

work done suggested another interesting problem, which might well receive attention; that is, as to how far the extent of the spatial pictures affects reproduction, and as to the individual peculiarities which experiments with spatial groups of various degrees of extensiveness would discover. This wouls apply, of course, to passages of temporal matter also. A more detailed discussion of this point will be returned to later. (See p 110).

In the case of the first Temporal passage, (See Appendix I p viii), the number of peculiar names, and the general nature of the ideas, proved to be rather serious handicaps. The length, too, was not properly adjusted to suit the requirements of the experiment. Consequently Passage Number II, (App I p x), was chosen, and arranged so as to overcome these difficulties. It may be added that the number of very unusual names was carefully watched in selecting each of the passages which were finally used. Further, in scoring, any ideas in a passage seeming to

pertain to the nature of the ideas of one of the other types, were noted, so that this difficulty could be overcome by careful marking.

Results and Conclusions.

The data obtained, are tabulated, and will be found in Appendix II. It will be noted that the size of the group is extremely limited, (forty-nine cases). The purpose of this work, however, was not to secure decisive results, but to begin a new line of attack upon the general problems of memory , and to see if any suggestive facts would be shown. As will be indicated, many closely allied problems have thus been isolated, with a view to continuing further the work along these lines.

TABLE NUMBER V, (Appendix II, p xxvi)

This table was compiled from the data contained in Tables I - IV (App II, pp xviii - xxv) as follows: The individual graphs of each student's results were studied, and the number of cases where marked superiority was shown in the case of the Temporal passage, was thus obtained. This was repeated with reference to superiority in Spatial and Logical memory. It will be seen that whereas 25 students were markedly superior in Temporal, only 6 were superior in Logical, and 3 in Spatial. In 13 cases, no distinct difference was shown, with respect to the sensible material, although, as would be expected, the results with nonsense syllables were in every case very much lower than the results with the prose passages.

The results of selecting those cases which showed marked inferiority in one kind of material, bear out these results in the case of the Temporal passage, only 3 students finding this to give the worst results.

To indicate more specifically the standard which was employed in compiling this table, a few typical graphs are appended.

Graph Number I, (App.II p xxxi), gives the results of the work of a student who found least difficulty with the Temporal material, and who met with comparatively little success in the case of the Logical passage. Cases such as this show how great variation in memory capacity exists, when sensible material, usually treated as a class unit, is subdivided into distinct elements.

Graph Number II (App II p xxxii) similarly shows that this student found Temporal matter easier to handle; but there is not so distinct a difference between Spatial and Logical as in the first case.

Graph Number III (App II p xxxiii) is an example of a student who finds each type of material to be of equal difficulty; and such cases as this were, of course, discarded in compiling Table Number V.

Graph Number IV, (App II p xxxiv), shows how this student found the Logical passage very much more difficult than either the Temporal or the Spatial passages, - the two latter being learned with almost equal ease.

Graph Number V, (App II p xxxv) and

Graph Number VI, (App II p xxxvi). -- Spatial material learned badly, compared with Temporal and Logical.

Graph Number VII, (App II p xxxvii)
Logical memory superior to Temporal, and Spatial memory very inferior.

These results seem to justify at the outset, the contention which led to this preliminary experiment on the subdivision of sensible material for purposes of investigating memory peculiarities. And if that one point alone can be thoroughly established, then this work will have achieved its aim, leaving concrete conclusions to later research.

Table Number V also includes a record of the cases in which retention for one type of material was superior to that for others. Retention was measured by the amount remembered after an interval of two weeks had elapsed between learning and recall, - keeping in mind not the actual amount remembered, but the relation of this amount to the percentage of the passage that was learned in the first place; i.e. the amount forgotten is the main factor on which this section of the results rests. Thus the best retentivity is shown in the case of Temporal and Logical material; the worst, in the case of Spatial material.

The small size of the group forbids us to draw any definite conclusions. Nevertheless, we seem to be justified in saying that memory for spatial material shows a distinct difference, (in this group, an inferiority,) from memory for logical and temporal material. The greatest difference appears to be between spatial and the other two types; and this is possibly what we might expect, since subjective opinion would seem to point to a greater similarity in the nature of the content of the logical and temporal selections. But the difference between the results for these two somewhat similar types of material is great enough to justify the distinction between them.

From these results the suggestive problem, of the relationship between abnormal or subnormal memory ability in one special type of material, and ability in certain school subjects, has been isolated. This is discussed later, under the heading "Further Problems". (See page 129).

Table Number VI, (Appendix II, page xxvii) shows the relative amounts learned at each of the first three repetitions. Here again spatial material appears to give results which differ markedly from those with logical and temporal material. The left hand section of the table shows that with the logical passage, most was learned in the first repetition, by 17 students, and in only 7 cases was the second repetition superior. This in is accordance with current views, - that the first repetition is the most improtant in any memory work. With temporal material, however, there were 22 cases which found the first repetition to give the best results, and 22 cases in which the second repetition was the best. With spatial material, the first repetition is of least importance, the second and third giving the best results in 17 cases. These figures are corroborated by studying the repetitions which gave the least amount of learning.

Again remembering the small size of the group, and therefore refraining from making sweeping conclusions, we may nevertheless say that the fairly popular opinion that the first repetition gives the best results, needs further verifying from the point of view of these new subdivisions of sensible material. In this way, fresh differences may be discovered, which may have far-reaching effects upon the laws of learning, especially if the correlation between ability in these elements and any school subjects is shown to be high.

Tables VII and VIII, (App.II pp xxviii -xxix) were compiled with a view to testing the law of the superiority of the first repetition from the point of view of the group and of sensible material taken as a whole. If the group had thus been shown to be abnormal from the point of view of former findings, then the above results might not be as significant as we have claimed then to be. Accordingly the number of cases in which the first repetition was

superior in all three types of material, was obtained, and this was repeated with reference to the second and third repetitions. The number of cases which showed the first, second, and third repetitions respectively inferior, in all three types of material, was next calculated.

Table VII indicates the validity of the general law, - that the first repetition, on the whole, is superior, 40 cases finding this to be true, as against 5 who found the second repetition the best, and only 1 who found the third repepition the best.

Table VIII also supports this from the point of view of the repetition giving the worst results. (In the case of students taking more than three repetitions to learn any passage, - a comparatively small group, - the first three only were used.)

These results show that while the general laws hold for the collective material, - for the so- called 'logical' or sensible material, they

do not necessarily hold in the case of each of the elementary divisions which are possible. Sensible material can be analysised into many types, more elementary in nature, and hence more uniform. If the problem were attacked from this angle, undoubtedly an increased understanding of the laws governing success in the various branches of learning would result.

Table Number IX, (App.II p xxx.) and Graph Number XI (App.II pxli). show a similar result. This table was compiled by averaging the amount learned at each repetition in each type of material. The graph was constructed from the table; but where the one hundred per cent mark had been reached, the value for subsequent repetitions was taken as one hundred.

From the graph we see that there is a slight superiority in the case of temporal material, over logical and spatial. There is also a very marked difference between the capacity for learning

sensible material and that for nonsense syllables.

The group results also show clearly that in the case of temporal, logical, and nonsense material, the first repetition is the best. In the case of spatial material, the second is the best. These facts bear out what was found in the analysis of individual results. (Table VI).

The order of recall shows that temporal material lasts longer than logical, and logical is retained longer than spatial. On the whole, spatial material was the hardest to learn, and was least remembered. Individual results would (with very few exceptions) likewise tend to bear out the fact that the old adage "Easy come, easy go" is false.

Criticisms

The limitations of so small a piece of work are indeed many and obvious. We may pass over the lack of conclusive evidence and the very restricted group with which the experiments were conducted, since our aim at this stage has been to suggest new lines of attack, rather than to arrive at definite experimental results. It is perhaps advisable, however, to suggest that one of the main criticisms of the method here employed will undoubtedly be from the standpoint of the equality of difficulty of these various types of material. How can we guarantee that the passages of spatial, temporal, imagery, and logical content are comparable units? Does the fact that a student does well with one passage, and poorly with another, indicate anything except that the material is not uniformly difficult? For example, we found that the group results were highest in the case of Temporal material. This may mean either that the temporal passage was comparatively more easy, or that these students possessed on an average superior

ability in memory for temporal material.

The question is an important one, but the difficulty thus suggested is not insurmountable. When the advocates of the use of nonsense syllables or of isolated words emphasised the fact that such material makes it a very simple matter to compose tests equal in quantity and quality, there are two significant points which need further consideration. Both of these points have been discussed already; but for the sake of emphasis, we reiterate that it is very difficult indeed to ensure that nonsense syllables or isolated words are of equal difficulty; and secondly, if in order to obtain this questionable uniformity, we use such material, what have we gained? What do tests with nonsense syllables indicate, after we have experimented with them? There is very little that can be deduced, that is of importance to education, from results of that type; and hence it seems hardly advisable to continue extensive research along these time-honoured lines.

But if we concentrate our attention on the various types of sensible material, the results are likely to give far more assistance in educational pursuits, since we are dealing with factors which are of vital importance to school life. Even if we sacrifice some element of equality of the tests employed, - and this is a supposition, rather than an admission, - we appear to have gained a great deal from the point of view of content. But it is possible, with care, to ensure that the different types of sensible passages *are* of equal difficulty. In the case of this experiment, for instance, although the size of the group is small, nevertheless the similarity between the curves of learning of the three sensible selections is so great as to indicate that they presented on the whole practically the same amount of difficulty. From the point of view of individual subjects, they are very different. But that is just what we are trying to discover; for these differences represent personal

peculiarities which may prove to be of great diagnostic value.

Also, by arranging the material so that each passage contains the same number of ideas, the same number of unusual names, (making that number as small as possible,) and by scoring the results in such a manner that any undue difference in quality is taken into consideration, equality can be secured more readily, and more surely, than in the case of nonsense material. Further, if this solution does not prove to be satisfactory, or if personal prejudices are not thereby overcome, the problem may be solved scientifically by establishing agem sex, pr mental ability norms, - a task which offers no very great difficulties whatever.

Further Problems.

In order to bring out more clearly the main significance of the ideas underlying this experimental work, a few problems are here suggested, which might lead to more decisive results. The solution of such problems would not only test the validity of this proposed method of procedure, but in all probability would also throw light on many phases of the learning process about which we are not at present very clear. In the course of a close study of the field, one discovers an infinite number of pathways which would be very interesting to explore empirically. But a few of the most obvious of these will serve the purpose of this paper, since it is not necessary or advisable to attempt to consider every detail of so complex a subject in a treatise of limited length. The inadvisability of taking up too much of the time of the class which acted as subjects, as well as other factors, have made it necessary to defer attacking these problems experimentally until some time in the near future.

As has been noted, these subdivisions of sensible material may be classified further into groups more elementary in nature, and future experiments will doubtless isolate these. The present investigation has suggested a few concrete differences which exist between various passages which have been grouped under one of the four general classes suggested at the outset. These will therefore be considered in turn.

Narrative Material may vary in several ways. The most obvious variation is perhaps in relation to the length of the time series which is involved in the passage being learned. For example, the narrative may consist of a series of events which take place during a very short period; or, it may involve a summary of the special events which follow in sequence over a considerable number of years. The role of habit is possibly of considerable importance in determining the peculiarities of individuals in respect to memory for such material; and it would be interesting to discover just how far these differences occur.

It is/ possible that the History specialist would differ greatly from the student of English, and, if so, the causes of the variations would be an interesting problem. If it were found that the students whose specialty was some such phase of literature as 'English novelists of the eighteenth century', were decidedlymore efficient with regard to temporal passages involving a short period of time, while students of Geology found those passages involving long periods of time more easy to learn, then some important information would be gleaned, and the effect of habit would be very clearly demonstrated.

Again, temporal passages frequently occur, in which the events are not recorded in direct time sequence. The reader is 'taken back' to some incidents which happened earlier; and the effect is often confusing to many individuals. Students of Political Science are being called upon to do this frequently; while many other subjects rarely require such a practice. The individual differences which could

possibly be brought to light in this respect, might conceivably show some definite bearing on their habits of thought; and in this way, further information could be obtained concerning the mechanics of memory.

The nature of the ideas themselves which are contained in the passage, undoubtedly has an important effect, whatever the type of material. In temporal passages, however, the incidents may vary considerably, from trivial, everyday occurrences, to events of great moment. It is possible that individual differences in this respect might again have some significant bearing on the habits and interests of the individuals themselves. The incidents in a military campaign would appear more vivid to a soldier than to a recluse. They would probably appear in totally different light to a student of History, and to a student of Chemistry. The role of habit in each case, it is anticipated, would be clearly established.

It is likewise easy to detect various kinds of Spatial Material. To ~~some~~ most students, the first passage used in this experiment, (Appendix I p v) was of so familiar a type, - involving relations of common objects in a room, - that it was too easy for our purposes. The second passage, (App II p vi) involved space relations which were much more extensive. Some of the introspective notes stated that the picture was too large - that it was of such dimensions that they could not 'get it all in! It is possible that the question is not one of 'smaller' or 'larger', - in any case, these terms are merely relative. The solution which appears more probable is such as has been suggested with reference to temporal material, and which is in accordance with the conception of memory as outlined earlier, - i.e. that 'habit' is the basic factor on which these considerations depend, The trained Army Officer, for example, would probably find great difficulty in visualizing the description of a complex minute structure such as a plant; and

it is equally probable that the Botany specialist would experience difficulty in visualizing the country over which several army corps were to advance. Our conceptions of space are purely habits; and it would be comparatively easy to show the effect of habit in such a case as this. During the war, thousands of instances were observed where men who had spent all their lives in London tenements, were useless on tactical schemes, although they made exceedingly efficient parade-square instructors. But when it was a question of remembering the dispositions of their neighbouring sections, as well as the position of the enemy, they were unable to do so unless these dispositions were illustrated on a diagram of small dimensions. Of course, it is not suggested that spatial memory for extended relations is the only factor in open warfare; but undoubtedly it is an essential feature in the make-up of a great general.

The role of habit, then, could readily be investigated in such a case. Passages involving space relations of all dimensions could be employed, and the individual differences would possibly throw a great deal of light on the problem. The method employed, unconsciously or consciously, by the subject, would also serve to clarify this problem somewhat. To the surveyor, for instance, the visual picture would probably contain certain specific relations which he had himself deduced, such as are noted in surveying a tract of country. The mathematician would possibly visualize a series of objects arranged in geometrical shapes. To such subjects, the picture would have more 'meaning', since past habits are being utilised very extensively; and in consequence we should expect a greater efficiency in subjects of this type.

Further, introspective evidence pointed to the fact that many individuals locate all spatial pictures in a region which is familiar to them. It is a

common thing in childhood to visualise any description in places which are known; and in after life the memories of these scenes are still linked with those places in which they were first located. In the present experiment, one student noted that it was difficult to learn the section of the spatial passage dealing with Hittin, because it was unfamiliar, - he could not 'locate it'. And if we examine the picture which any description calls up, we find that certain elements are located in places with which we are familiar.

The same applies to the manner in which the pictures are built up. Certain sections of the description call up visions of places well known to us. The associated elements may be utterly unrelated to each other. But each section has its place; - this hill-scene is located near a certain Scotch village, yet the house is one which could exist only in Egypt, knowledge of which may have been obtained from literature or from actual experience.

This is merely localisation of a different type; and it is a factor which many systems of 'memory training' utilise. Such facts might be demonstrated by tests of memory for spatial material, supplemented by introspective data. And the type of individual who does not habitually do this, would probably be found lacking in memory capacity of this type

With *Logical Material*, the role of habit could be demonstrated by subjecting students of Philosophy, Political Science, Law, Sociology, etc., to tests involving ideas of various types, - familiar and unfamiliar. The successful student of Philosophy should be able to learn a complicated passage of logical argument involving such terms as 'freedom', 'immortality', 'time', 'causality', etc., much more easily than the successful student of Law, - although, of course, the passage, to be of use in this connection, would have to be composed in such a way that it would have no specific resemblance to any philosophical construct

known to him. Even here it is possible that the various units would be associated with some definite philosophers whom he had studied. In learning a passage such as the one actually given in these tests (Appendix I, p xii,) the lawyer would probably be able to appreciate its significance far more readily than then the philosopher; - i.e. it would have more meaning,X and hence would tend to be remembered more readily.

These points could be proved or disproved by testing special groups of subjects with material involving different types of ideas. But there is a question with which we are immediately concerned, suggested by the above contention. Suppose we are dealing with pupils of less mature age; how are we to determine those who are superior in memory ability for logical material? Is it possible to conclude that such superiority does exist, from any tests, since habit plays such an important part?

Suppose we select for this purpose, certain passages of logical material, in which the ideas are familiar. Each branch of logical argument deals with a large number of ideas which are quite commonly used by every person of normal intelligence. Naturally, such passages would be much less difficult thanthose which would be employed in determining the role of habit in these various branches. But the subjects for the present experiment would likewise be less mature, and hence more suited to the less abstract type of material. To determine superiority in 'logical memory', then, it would be necessary to discover a superiority in all of the various logical passages, since the ideas themselves are of constant difficulty, and the relationships involved are fairly similar. It would appear that the probability is that a pupil who reacts favourably to a logical passage involving sociological terms, the significance of which is quite familiar, would also react favourably to one composed of

simple, familiar, philosophical terms, since the equal familiarity presupposes a similarity in the efficiency of the previously formed habits. The logical passage employed in the work reported here, was chosen, of course, with reference to the nature of the subjects being tested. And in reality, the above assumption, - which should be tested by further experiment, - underlies the conclusions which were made regarding the results which that passage gave. Since our conclusions are not final, and since they were made with a view to further investigation, such an assumption is quite justifiable.

Another problem in connection with logical material, and one which must have important bearing upon the subject of 'methods of learning', and 'methods of presentation', is concerned with the position in the passage of the main sentence of the argument. What differences result in ease of learning, when the crux of the argument is stated

at the beginning, the middle, or the end of the passage? Is it easier to follow and subsequently reproduce a train of reasoning which leads up to the main conclusion, and then adds some more points in support of that contention? Or should the main sentences be placed at the beginning, or at the end?

To illustrate this further, a selection of logical material is appended, the main point of which has been underlined. (Appendix I, page xv). This passage could be given to three groups, equal in ability to learn logical selections, (as determined by a series of experiments with logical passages of various types); - to one group, the passage would be presented with the main argument stated at the beginning; the second group would learn it with that part at the end; and the third, with the topic sentence in the middle. Very valuable information might thus be obtained from the point of view of presentation of argument, etc.

From these considerations, we may pass for a moment to a few general problems which concern all types of sensible material. There are a great number of these that are worthy of notice; but of necessity, we shall confine ourselves to a few of greatest moment.

The question of 'methods' of learning was suggested by the last problem considered with logical material. The evidence in favour of the superiority of the 'entire' method of learning, would seem to need supplementing by data obtained from investigations performed with each kind of logical material. It seems highly probable, for instance, that material involving spatial relations could be best learned if the passage were divided into sections which contained elements related in certain specific ways. We have already noted[1] the greater efficiency that results with such material if the space relations are grouped in geometrical form. The suggestion seems feasible that such groups would be better grasped if learned separately

and later related to each other in ~~some~~ the larger picture, Unless the units of spatial passages are related in some such manner, the material might appear as disjointed as a series of nonsense syllables. Those who find no difficulty with this branch of the work almost invariably read meaning into the space relations, which assists the memory process very considerably.And such 'meaning' usually takes the form of individual groups of definite shape.

In addition to this general problem of method of learning, the most efficient distribution of effort should be studied in relation to individual peculiarities, and to each kind of material. The distribution is largely dependent on the superiority of the first repetition, as well as on fatigue, etc. and hence this question also needs verifying in a similar way. And the same applies to the maximum length of passage which can be handled most efficiently, and, in fact, to most of the'laws' which have been established by using material which

has been criticised earlier.

It was stated (pp. 58-59) that a more careful investigation of the relation between immediate and delayed reproduction, would throw light on the validity of the behaviouristic conception of memory. If the subject learns rapidly, he does so partly because his field of habits is large and effective. This being the case, there is more likelihood, other things being equal, of his 'going over' these habit paths in the course of his experience, and hence we might expect retentiveness to show high correlation with rate of learning. The result should theoretically be the same whether verbatim repetition was required, or whether the substance only of the material was reproduced. This would depend somewhat, however, on the type of material that the individual was habitually dealing with to a greater extent, during the interval elapsing. Hence we would suggest that a group of subjects suitable for such an investigation should be consistent, in that

they all showed superiority in memory for one type of material, e.g. for spatial material. Another group employed should be those who were consistently poor in one branch, -e.g. those who found spatial material to be hardest to learn. Their retentiveness for this material, should - according to the foregoing arguments - be poor also, since it is assumed that the feeble capacity in this type of memory is due largely to sparsity of habits of this kind, and to lack of interest in consequence. If the results of these subjects with familiar and unfamiliar material showed a high degree of agreement, then the evidence in favour of the habit theory of memory would be very great.

The problem of obliviscence, - a study of the individual curves of forgetting for each of the types of sensible material, would possibly furnish further evidence in this connection. It is expected that the curves would vary in a manner similar to the variations of the learning curves. The problem of reminiscence, and its relation to content, age of

subject, intelligence, special abilities, etc. would be involved. If reminiscence were found to operate sufficiently to warrant further detailed investigation, it would be necessary to determine whether its cause were due to the fact that, during the interval, the subjects had been 'fixing in' the habits formed during the learning process. As introspection would be the chief method by which this could be determined, the experiments would necessitate a select group of subjects.

A systematic investigation of the development of ability in each of these branches, if performed with the same children at intervals during their school career, would give results which might prove to be of definite value. It might thus be discovered that the developments ran parallel to certain specific lines of scholastic progress. For instance, the development of spatial memory, compared with the progress of the group, and of each individual, in mathematical subjects, might afford evidence

as to how closely these memory abilities follow the trend of habit formation. It is quite clear that no 'formal discipline' implications enter in to such a problem.

From these results, some definite information with regard to 'training' of memory might be obtained. Instead of using nonsense syllables for memory training, as did Ebert and Meumann,[104] material similar to that employed in the present experiments could be used, in such a way that improvement in capacity for each type of material could be detected; and introspective notes might assist in directing progress. The training would involve, (a) the building up of correct habits, using methods which have been proved experimentally to give the best results. This would involve a knowledge of the best distribution of pauses, length of passage, method employed etc.

(b) Investigating the effect of memorising spatial ~~memor~~ passages on spatial memory, etc

(c) Training in sensible/ memory generally, avoiding' ~~roteverbatim~~ 'rote' or verbatim repetition in all possible cases.

[104] Rusk. op.cit. p 225

Again bearing in mind the fundamental contention with regard to the basis of memory, the problem of the relation of the ability of children to the ability of adults, would likewise prove interesting. It is generally supposed that the adult is superior in sensible memory, and confirmation of this with respect to each of the types of material would be gratifying to those who regard such memory as dependent on the utility of past habits. The question as to the relation of memory ability to intelligence, is difficult to investigate at present. Final solution will have to be deferred until the means of estimating the latter are more efficient. But it is reasonable to suppose that a person who obtained high results in each type of memory, where the passages did not contain ideas which necessitate an intimacy with special branches of study, would be a person of high intelligence. It is therefore possible that the future intelligence tests will more and more rely upon tests such as we are here advocating.

The diagnostic value of these memory tests has been referred to several times during the discussion of further problems. It would seem that we are justified in expecting that such an advantage is likely to follow in the train of future investigation. Inability to visualise space-relations, for instance, would certainly seem to be a handicap in Geometry. Although time did not permit the undertaking of this problem on any reliable scale, an interesting case suggested the advisability of so doing at a later date. In one instance of inability to reproduce the spatial passage successfully, the subject was questioned as to her own explanation of the fact. She said that the images were isolated, and that no idea of relation of the images remained. Questioned further as to her reaction to mathematical problems, we learned that she had been trying for several sessions to master one of the junior courses in this subject, so far without success.

The two graphs, Numbers IX and X, (App II pp xxxix - xl), may illustrate this further.

The student whose results are shown on Graph NoIX is obviously weak in logical memory. She is also weak in languages. Number X illustrates/ a case of the reverse kind, - a student who is strong in language subjects, and likewise superior in logical memory. These cases give no conclusive evidence, but the problem is worthy of further investigation.

There remain two further points which bear directly on this method of investigating the memory peculiarities of individuals, and the significance of such peculiarities themselves. Passages of Sensuous content have been referred to earlier; and although the data obtained with such passages were discarded, for reasons already given, it was nevertheless intended to include this sectionof the work in the present paper.

The subject of imagery and the role which it plays in memory activities, is an old and controversial one. It is significant from the

standpoint of the present contention, to determine just how far it is a factor, and what specific type or types of imagery predominate in habitual memorising. In the past, determinations of this kind have usually taken the form of questionnaires,[105] memory tests involving the use of lists of words of preponderatingly visual content,[106] auditory content, etc.; and various introspective methods have been employed.[105] The subjective nature of introspection makes it advisable to use such methods with caution, and to substitute objective determinations where possible. Consequently we need concern ourselves with a discussion of the merits of using, for memory purposes, lists of words, classified according to the type of imagery which usually accompanies their apprehension, as compared with the suggestion here made, that the task be performed by using sensible passages, classified accordingly.

We have already contended that isolated words are not suited to investigations of this type. In the first place, it is a questionable procedure

---

[105] Titchener: 'Experimental Psychology', Qualitative, Students' Manual, pp. 195-200.

[106] Rusk, op. cit., p.86

to take a word out of its setting, and, after using it for test purposes, to assume that the results so obtained are valid in the case of sensible passages involving the use of such words. Many of the arguments employed in criticising nonsense syllables and words as material for memory tests, apply im the present case. By composing passages rich in vivid imagery, (such as those referred to earlier, Appendix I pp i- iv), we obtain material in which the quality of the images is of greater uniformity, than in the case of isolated words. For the true meaning of the words is thereby more definite, and less subject to individual variations; and the images called up have an effect which enables us to measure individual differences in this capacity more accurately, since the other variable factors are reduced.

Accordingly we would suggest that this phase of the work be attacked by using passages constructed in such a way that they are rich in imagery, and

and that memory capacity for such material be analysed in comparison to capacity in other types, and to ability in school subjects. The imagery passages may be classified, so that one kind contains a uniform mixture of the various types of images, another is composed entirely of visual images, (i.e. words and phrases denoting objects or scenes which are apprehended visually by normal persons,) another, deals with auditory images, and so on. In this way a more concrete determination of the actual effects of such material in individual learning, is possible.

A further subdivision of sensible material which could possibly be advantageously investigated separately, is suggested under the heading 'passages of emotional content'. Individual peculiarities have been studied in this connection with reference to isolated words;[107] and the objections ~~raised~~ to such a procedure, raised when discussing sensuous material apply even more forcibly here. It is indeed

---

[107] Cf Rusk. op.cit., p.86

impossible to assume that such words as 'joy', 'hope', 'care' etc are equal in difficulty, since the meanings vary in richness to a greater extent than with any other type of word. But by including them in sensible material, their true significance is more accurately brought out, and hence the memory peculiarities are more accurately measurable. It would be interesting to discover just how far the writer succeeds in calling up the emotional picture which he attempts to arouse, which he himself feels, or which he desires the reader to feel in order to make his word-picture more real. The effect of the intensity and nature of the emotion thus aroused on ability to recall the passage would be a factor which would vary considerably in different individuals; and an objective determination of this type would give some further information regarding the true nature of memory, and the conditions under which it is most efficient.

It is impossible to summarise the foregoing,

since an attempt has been made to cover a vast amount of material in a short space. It is perhaps in order, however, to say that the main purpose of this experimental work, and of the few problems which have been suggested as being worthy of consideration, is to suggest a comparatively new line of attack for a very old task; and to emphasize the necessity for very careful analysis of the material which is used in memory tests, since the conclusions to be drawn from any research must be considered specifically in the light of the mental factors involved in remembering such material.

APPENDIX I

Passages of Prose Referred to in this Essay.

Imagery Passage, NumberI. (From, George Eliot's "The Mill on the Floss", Chapter I, page 1)

A wide plain, where the broadening Floss hurries on between its green banks to the sea, and the loving tide, rushing to meet it, checks its passage with an impetuous embrace. On this mighty tide the black ships - laden with the fresh scented fir-planks, with rounded sacks of oil-bearing seed, or with the dark glitter of coal - are borne along to the town of St Ogg's, which shows its aged,red roofs, and the broad gables of the wharves between the wooded hill and the river brink, tinging the water with a soft purple hue under the transient glance of this February sun. Far away on each hand stretch the rich pastures, and the patches of dark earth, made ready for the seed of broad leaved green crops, or touched already with the tint of the tender-bladed autumn-sown corn. There is a remnant still of last year's golden clusters of bee hive ricks rising at intervals beyond the hedgerows;

and everywhere the hedgerows are studded with trees; the distant ships seem to be lifting their masts and stretching their red-brown sails close among the branches of the spreading ash. Just by the red-roofed town the tributary Ripple flows with a lively current into the Floss.

Imagery Passage, Number II, - 'The Island'.

(Composed for the purpose of this experiment).

The schooner, with her white sails glistening in the bright sun, sailed smoothly into the still lagoon and lowered her creaking anchor-chain into its blue depths. Presently a boat sped from her side, and landed on the flat, sandy shore its cargo of swarthy bare footed, red- capped sailors. These men, after their long voyage on the Pacific, during which there was nothing to break the monotony of the blue ocean around them, the scorching sun above them, and the hot, creaking deck-boards beneath them, feasted their eyes on the spectacle that the island presented. On the left, and looming dim and shadowy in the morning haze, was a mass of grey rock, down the face of which they could dimly discern a thin, irregular white streak, whence proceeded the welcome sound of trickling water, fresh, cool and abundant. Tall trees, with their tuft of foliage appearing grey- green through the mist, promised the cool refreshment of cocoanut milk, a

truly royal delicacy for the half-fainting sailors, with their throats parched, their lips cracked and their tongues dry and leathery from their long privations. A few yards in front, the thick and prickly undergrowth revealed a profusion of yellow and white flowers, with here and there a cluster of red berries. The smooth white sand, beginning to sparkle in the morning sun, felt pleasant beneath their blistered feet. The waters of the lagoon gently lapping on the shore made a pleasing sound, while the deeper booming of the ocean waves as they broke in foam on the reef was borne faintly to their ears. As they advanced there was a sudden fluttering of wings, and a flock of screaming birds rose into the air and disappeared into the woods beyond.

Spatial Passage, Number 1.

(From the introductory, stage-setting of
'Getting Married', by G.B.Shaw.)

The windows high up on the wall | look north and south. | The north window is the largest; | and if we look into the kitchen through it, | we see facing us | the South Wall | with small Norman windows | and an open door | near the corner to the left. | Through this door | we have a glimpse of the garden | and of a garden chair | in the sunshine. | In the right hand corner | is an entrance | to a vaulted | circular chamber | with a winding stair | leading up through a tower | to the upper floors of the palace. | In a wall to our right |, is the immense fireplace | with its huge spit | and a collection of old iron and brass instruments. | In the rear end | of the left hand wall | a small Norman door | gives access to the bishop's study. | (28 points)

Spatial Passage, Number II

(From "Saladin", by Stanley Lane-Poole,
'Heroes of the Nations' Series, pp. [illegible])

Saffuriya was an unwalled town on the low hills north-west of Nazareth. The Church of St. Anne stood in the midst, and a strong tower on the hill above overlooked the brown cornfields which stretched towards the rugged mountain chain of Upper Galilee, and eastward to the plain over Tiberias - an open and waterless plateau. The fountain of Saffuriya lay a mile towards the south, in an open valley full of gardens.

Saladin's camp was ten miles to the east, upon the plateau near the little village of Hittin. The place was surrounded with olives and fruit trees, and a good spring, - copious and fresh, - flowed on the north-west into the gorge of Wady Hamman. There was plenty of water in the valleys hereby. From the peak of Hittin the watchman looks towards the west over a sunburnt plain, with long grey ridges,

dotted with towns to north and south. Behind him lay the lake of Galilee, seventeen hundred feet below. [28 points]

Temporal Passage, Number I.

(From, "Julian", by Alice Gardner,

'Heroes of the Nations' series, pp. 317-9)

After a three days' stay in Hierapolis, the army marched on eastward, crossed the Euphrates by a bridge of boats, halted for a day at another Batnae, (in Osroene), and proceeded to Carrhae. Here Julian held a great review of his troops. Thence two courses were open to him by which to reach upper Asia. He might strike across Mesopotamia eastwards, past Nisibis to the Tigris, or he might march southwards to Circesium and so onwards. While he was thus deliberating, news came that the Persians were making raids on the peoples subject to the Romans, apparently inthe neighbourhood of Nisibis. This decided him to adopt a plan to which he was already inclined, and to dispatch a considerable force eastwards, that might hold the brigand bands in check, effect a junction with Arsaces, ravage the provinces on the Assyrio-Armenian frontier, and

subsequently join the main body in Assyria. This detachment was placed under the command of Sebastian. With the main host, after a feigned movement towards the Tigris, Julian proceeded south, and reached Calinicus on the 27th of March. Here he celebrated the festival of the Mother of the Gods, and was rejoined by his fleet. He then proceeded, in hopeful spirits, down the Euphrates to Circesium. This town possessed a considerable garrison, which Julian is said to have strengthened. He seems not yet to have abandoned the plan of keeping a line of communications behind him. Or it may be that the last important place on Roman soil seemed specially ~~wethty~~ worthy of defence.

Temporal Passage, Number II.

(From, "Saladin", by Stanley Lane-Poole,
'Heroes of the Nations' Series, pp.175-6.)

Saladin stayed two months at Aleppo. On 14 August, 1183, he left for Damascus. Much had happened during his long absence in the north. His brave viceroy was dead, and the Franks had grown bolder. They had ravaged Busra and Zora and all the country even to a few miles from Damascus, destroying the crops and orchards and laying everything waste. They had recovered the rocky fastness in the Suhite. Reginald of Chatillon had even conceived the daring project to invade Arabia, destroy the tomb of "the accursed Camel driver" at Medina, and raze to the ground the holy Kaaba of Mecca. He transported his ships in sections, and, sending his fleet to sack the port of Aydhab, with two vessels he blockaded Eyla. The Egyptian fleet was soon in hot pursuit, and Admiral Lulu, after easily relieving the blockade of Eyla, came up with the main body

of the expedition. The sight of the Egyptian squadron drove them hurriedly on shore, and they made for the mountains. Lulu mounted his sailors on horses, and catching the enemy in the gorge, cut them to pieces. Reginald escaped, but most of his men were killed. No quarter was given except to a few prisoners who were sent to Mecca to be slaughtered like goats at the annual sacrifice of the Pilgrimage.

Logical Passage

(From Macaulay's "History of England",
Vol.IV,p.479 (Porter and Coates)

It was also urged in Anderton's favour, - and this was undoubtedly an argument well entitled to consideration - that a distinction ought to be made between the author of a treasonable paper and the man who merely printed it. The former could not pretend that he had not understood the meaning of the words which he himself had selected. But to the latter these words might convey no idea whatever. The metaphors, the allusions, the sarcasms, might be far beyond his comprehension; and, while his hands were busy among the types, his thoughts might be wandering to things altogether unconnected with the manuscript which was before him. It is undoubtedly true that it may be no crime to print what it would be a great crime to write. But this is evidently a matter concerning which no general rule can be laid down. Whether Anderton had, as a

mere mechanic, contributed to spread a work the tendency of which he did not suspect, or knowingly, had lent his help to raise a rebellion, was a question for the jury; and the jury might reasonably infer, from the change of his name, from the secret manner in which he worked, from the strict watch kept by his wife and mother, and from the fury with which, even in the grasp of the messengers, he railed at the government, that he was not the unconscious tool, but the intelligent and zealous accomplice of traitors. The twelve, after passing a considerable time in deliberation, informed the court that one of them entertained doubts. Those doubts were removed by arguments; and a verdict of Guilty was found.

The fate of the prisoner remained during some time in suspense. The Ministers hoped that he might be induced to save his own neck at the expense of the necks of the pamphleteers who had employed him. But his natural courage was kept up by

spiritual stimulants which the non-juring divines well understood how to administer. He suffered death with fortitude and continued to revile the government to the last.

Logical Passage, to illustrate the suggested problem as to the arrangement of the passage itself. (See Page 120).

From Macaulay's "History of England",
Vol.V, p.172 (Porter and Coates).

If William spared, employed, and promoted men who had been false to him, it was not because he was their dupe. His observation was quick and just; his intelligence was good; and he had, during some years, had in his hands proofs of much that Fenwick had only gathered from wandering reports. It has seemed strange to many that a prince of high spirit and acrimonious temper should have treated servants, who had so deeply wronged him, with a kindness hardly to be expected from the meekest of human beings. *But William was emphatically a statesman. He knew that he must work with such tools as he had.* Ill humour, the natural and pardonable effect~~s~~ of much bodily and much mental suffering, might sometimes impel him to give a tart answer. But never did he

on any important occasion indulge his angry ~~s~~ passions at the expense of the great interests of which he was the guardian. For the sake of those interests, proud and imperious as he was by nature, he submitted patiently to galling restraints, bore cruel indignities and disappointments with the outward show of serenity, and not only forgave, but often pretended not to see, offences which might well have moved him to bitter resentment.

APPENDIX II

Data, Graphs, Tables, etc.

TABLE I.- Results obtained with Temporal Material.

	Name.	Readings 1	2	3	4	5	6	Recall
1	Auxier G W	38	80	95				77
2	Baker A S	46	92	100				73
3	Barnett B J	45	81	100				95
4	Bell Mary	27	42	85				27
5	Bell Mildred H	40	93	97	100			92
6	Borden Florence	69	96	100				100
7	Boyd Wallace	31	62	84	86			55
8	Brown C B.	45	96	100				95
9	Brown Gladys O	39	65	73	89			
10	Butler E L	50	100					84
11	Chappell N T	35	73	96				77
12	Chambers A L	45	81	88				45
13	Clark R	19	70	94				
14	Creighton Isobel	54	96	100				
15	Dixon-Craig C	85	96	100				
16	Downey Melvin J	31	82	96				17
17	Emmett F J	50	89	94				67 2
18	Froman D K	52	89	100				85
19	Graham E	16	42	77	89			19
20	Macaulay M G	27	52	68				
21	Hamilton R C	64	83	98	97			66
22	Maclennan A H	42	72	100				83
23	McCray A	50	85	100				83
24	McDonald M N	30	86	96				30
25	McLean Jean C	25	32	64	82			39
26	McNeil A O	42	88	97				52
27	Moorhouse Josephine	26	39	49	60	80		34
28	Newhouse Lottie	27	65	89	100			69
29	Nix M	38	61	88	98			
30	Oke W	7	30	58	66	85		34
31	Parmelee Grace	21	36	67	93			69
32	Philp C W	45	80	95				79

Table I Contd.

	Name	Readings 1	2	3	4	5	6	Recall
33	Pratt H E	29	70	92				81
34	Redig Jessie	58	96	100				78
35	Reed Kathleen	20	46	59	100			84
36	Roberts M N	37	74	95				
37	Sharman L	60	79	100				80
38	Shillington Frances	65	78	92				88
39	Skitch C H	78	90	100				
40	Sorenson G	65	80	96	96			93
41	Stewart Harriet	19	50	80	80			58
42	Stuart E	85	100					81
43	Swain Rita M	63	88	100				80
44	Thompson Doris	4	43	86				60
45	Thorpe R	92	96					
46	Treffry H W	54	96					81
47	Weir Marjorie	27	80	93				57
48	Wright E K	84	100					87
49	Young O K	88	96	100				80

N.B. In the following tables, the number corresponding to each student, is used instead of the name.

TABLE II

Results obtained with Spatial Material.

Student's Number (see Table I)	Readings 1	2	3	4	5	6	Recall
1	33	70	96				96
2	32	64	89	93			75
3	19	46	57	89			75
4	46	68	72	89	97		32
5	42	88	92	100			83
6	50	85	96	100			100
7	28	53	89	100			71
8	28	68	84	88			67
9	50	71	85				
10	25	67	89	100			82
11	33	70	88				67
12	22	40	55	82			20
13	21	42	70	91			71
14	38	75	89	100			
15	54	85	92	100			85
16	14	68	86				23
17	42	85	92	100			86
18	28	61	80				65
19	14	57	71	89			22
20	8	33	55	85			80
21	24	62	76	98			64
22	43	74	100				97
23	40	71	88	100			89
24	19	26	70	86			46
25	12	54	89				44
26	17	72	97				51
27	22	44	42	60	71		34
28	18	35	53	68	82	96	57
29	30	64	75	97			91
30	15	40	75	70	85		50
31	39	69	93				61
32	50	81	96				64

Table II Contd.

Student's Number.	Readings 1	2	3	4	5	6	Recall
33	29	40	74	92			29
34	37	70	93	96			81
35	21	61	89	100			
36	39	67	100				
37	36	75	86	96			64
38	20	79	94				2
39	50	75	93				
40	50	70	96	100			89
41	14	32	54	93			15
42	71	96					71
43	52	72	90	96			71
44	14	45	86				75
45	88	97	98				~~100~~
46	43	79	100				~~72~~ 100
47	21	72	89	100			~~84~~ 72
48	71	78	100	96			~~93~~ 84
49	64	82	100				93

TABLE III

Results obtained with Logical Material.

Student's Number (See Table I)	Readings 1	2	3	4	5	6	Recall
1	38	85	96				43
2	46	60	78	100			93
3	48	59	82	92			90
4	30	48	89				45
5	33	93	89	100			63
6	47	77	100				95
7	20	55	85	90			52
8	24	69	79	85			60
9	45	74	97				
10	66	81	100				88
11	25	68	93				73
12	29	55	77	85			25
13	56	78	89	93			74
14	48	78	89	96			
15	66	88	96	100			
16	14	58	80				21
17	41	74	86	92			56
18	33	52	74	77			63
19							
20	44	63	79				61
21	54	82	96				68
22	33	78	88	96	100		80
23	58	66	93	100			88
24	16	22	40	83			33
25	4	44	59	59	67		11
26	41	72	93				61
27	30	49	55	65	80		51
28	34	67	69	77	85	100	70
29	40	55	78	81			
30	34	48	70	80			66
31	37	66	70	89	89		89
32	45	70	88	97			75

Table III Cont'd

Stusent's Number	Readings						Recall
	1	2	3	4	5	6	
33	34	72	92				59
34	52	59	81	98			62
35	56	74	93				80
36	11	41	74	78			70
37	55	73	89	100			76
38	67	93	100				84
39	50	66	69	69			
40	49	60	81	93			85
41	41	56	85	85			58
42	92	100					96
43	56	74	89	93			65
44	19	55	73	97			87
45	63	78	93				
46	48	56	74	90			67
47	44	52	85	100			72
48	59	96	96				88
49	52	74	92	96			82

TABLE IV.

Results obtained with Nonsense Syllables.

Student's Number (See Table I)	Readings 1	2	3	4	5	6	7
1							
2	18	20	29	38	46	60	78
3	9	6	17	12	17		
4	20	36	49	56	71	77	82
5	22	47	50	50	70	67	70
6	22	34	30	32	54	81	94
7							
8							
9							
10	3	3	11	17	17	15	24
11	13	20	20	20			
12	17	30	40	55	63	63	78
13	21	11	11	15	15	19	23
14							
15							
16							
17							
18	26	35	39	51	57	72	
19	16	26	26	51	68	82	100
20	14	11	17	14	20	33	33
21	20	23	30	36	40	40	50
22	21	33	56	78	81	93	100
23	17	30	34	41	43	50	65
24							
25	17	23	38	47	46	58	64
26	41	64	77	84	90	97	
27	30	45	50	60	80	81	
28	5	12	17	13	40	42	43
29	5	11	19	25	29	30	34
30	3	2	4	4	6	3	2
31	12	19	30	45	61		
32							

Table IV Contd.

Student's Number	Readings. 1	2	3	4	5	6	7
33							
34	23	32	38	32	42	56	70
35							
36							
37	26	50	73	78	80		
38	25	50	74				
39							
40							
41	23	33	55	63	71	88	85
42	23	28	42	56	79	87	100
43	14	26	32	43			
44	3	16	45	75	79	89	100
45							
46	12	16	13	22	32	32	43
47							
48							
49							

TABLE V.

BEST				WORST			
Temporal	Spatial	Logical	Not Counted	Temp.	Spat.	Log.	Not Counted
25	3	6	13	3	14	16	14
Retention:							
13	9	15	2	11	15	12	1

TABLE VI

BEST			WORST		
Temporal	Spatial	Logical	Temporal	Spatial	Logical
1st Repetition					
22	7	17	7	23	13
2nd Repetition					
22	17	7	13	11	22
3rd Repetition					
4	17	14	20	8	11

TABLE VII

GREATEST AMOUNT OF LEARNING		
1st Repetition	2nd Repetition	3rd Repetition
14	5	1

TABLE VIII

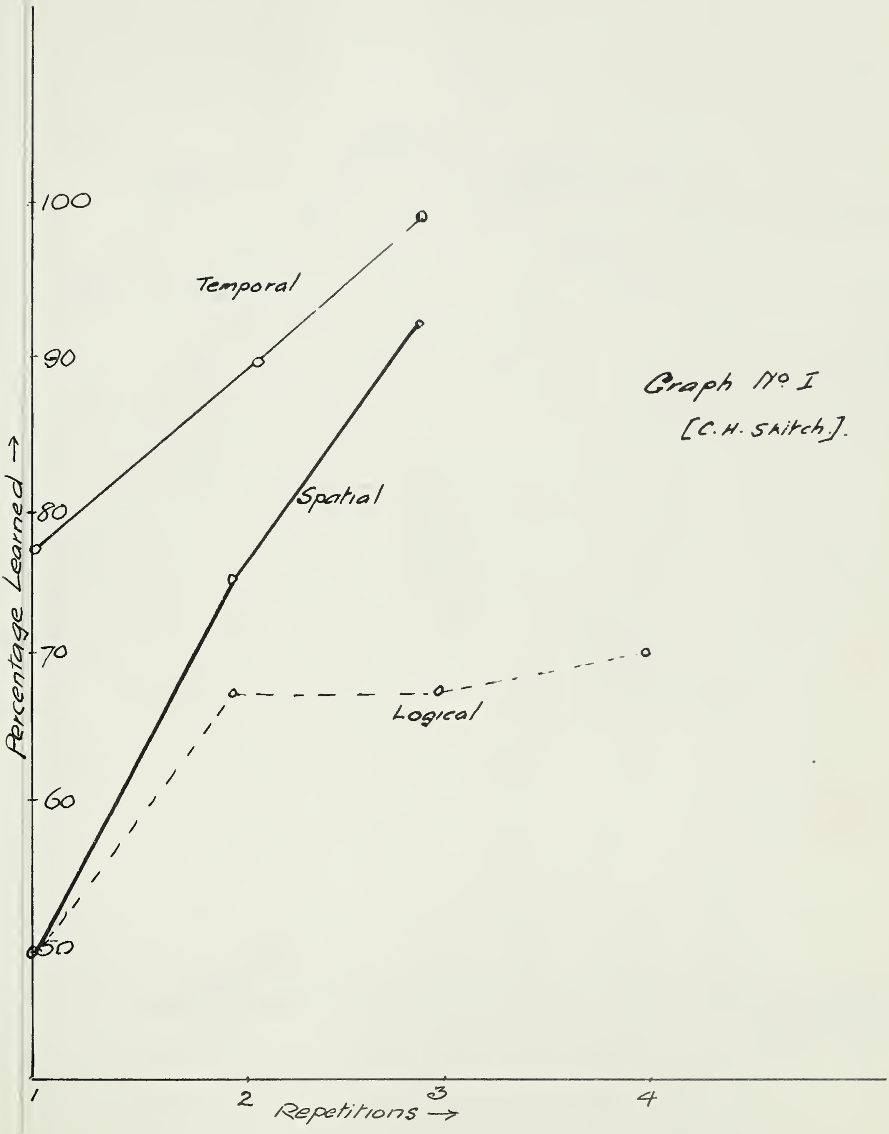
LEAST AMOUNT OF LEARNING		
1st Repetition	2nd Repetition	3rd Repetition
1	3	18

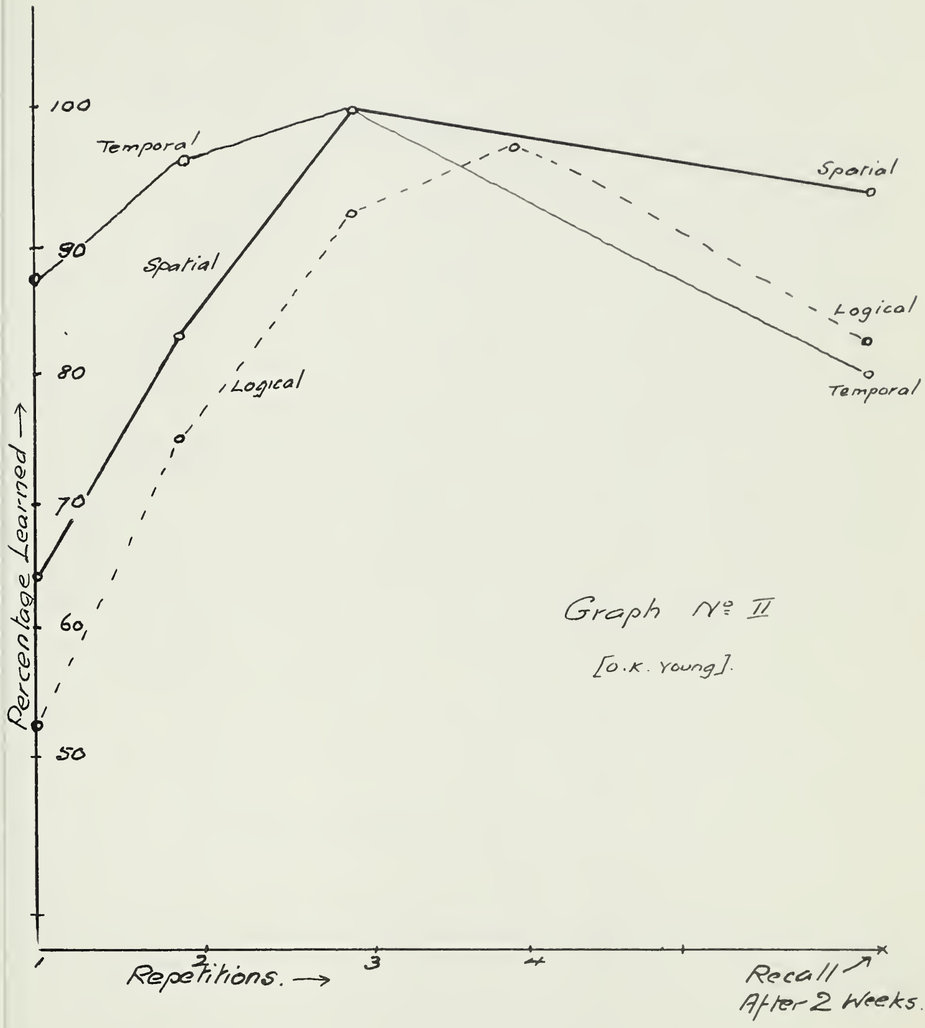
TABLE IX

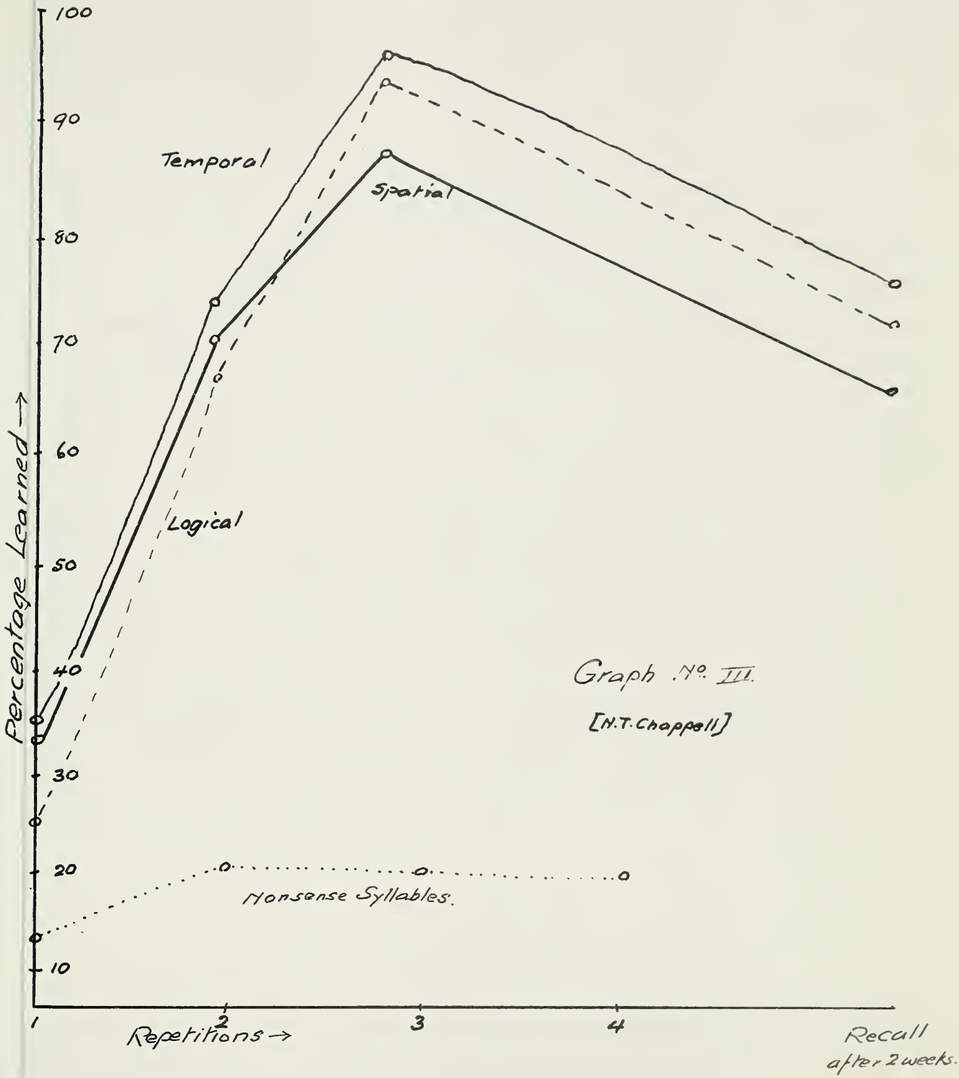
Average Amount Learned at Each Repetition.

	Readings 1st	2nd	3rd	4th	5th	6th	Recall
TEMPORAL	43.8	74.9	(a) 89.8 (b) 90.2	(a) 88.3 (b) 96.3	(a) 82.5 (b) 99.3		68.5
SPATIAL	30.8	64.0	(a) 83.5 (b) 83.9	(a) 92.0 (b) 94.8	(a) 86.3 (b) 98.9	(a) 96.0 (b) 99.9	65.5
LOGICAL	41.8	66.3	(a) 83.2 (b) 83.6	(a) 88.6 (b) 92.2	(a) 84,2 (b) 98.3	(a) 100 (b) 100	67.3
NONSENSE SYLLABLES	23.6	33.9	42.7	51.3	59.0	60.7	

(a) Readings - Average rating for that Reading.
(b) ,, - Averages, counting all cases, allowing maximun values for those who had learned the passage before that particular reading.

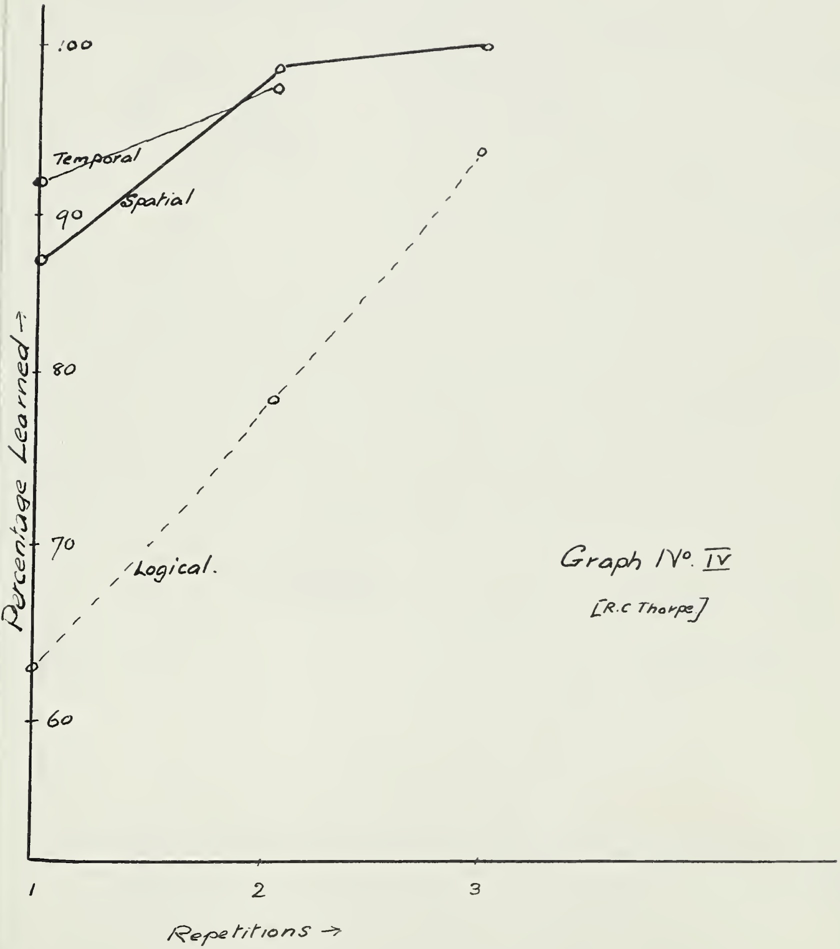

Percentage Learned →
100
90
80
70
60
50
Temporal
Spatial
Logical
Graph No I
[C.H. Skitch].
1
2
3
4
Repetitions →

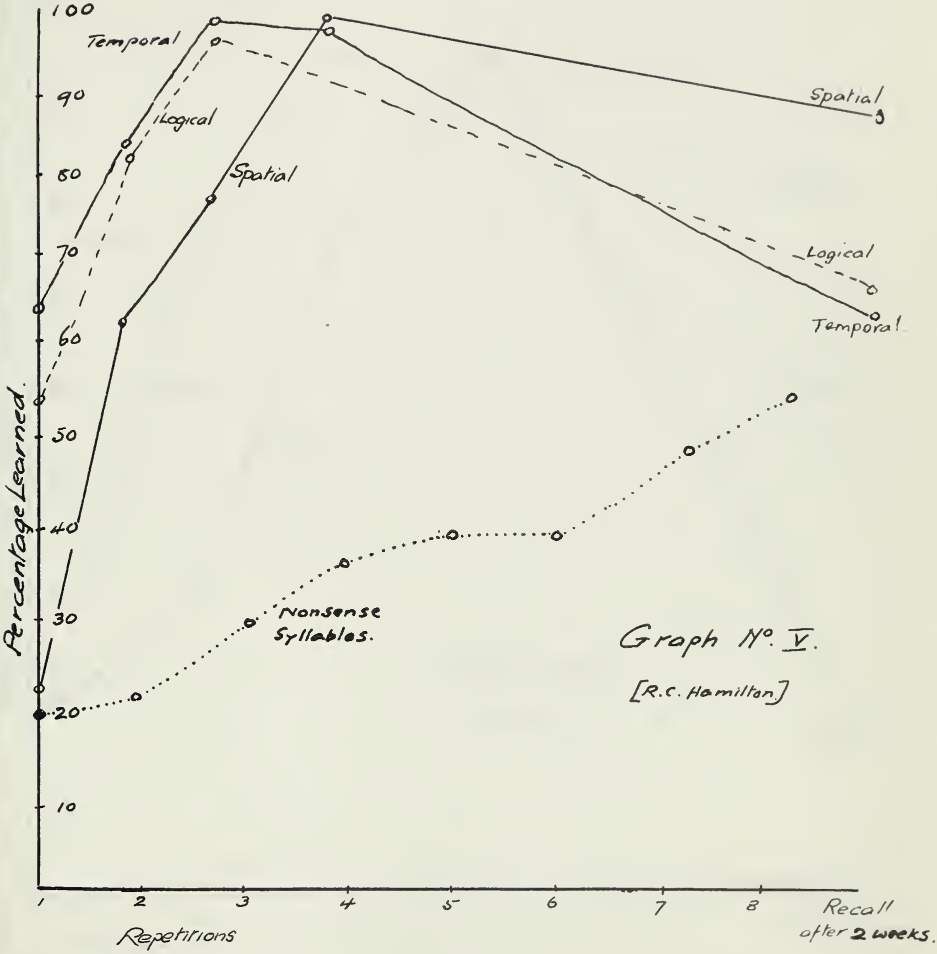

100
90
80
70
60
50
Percentage Learned →
Temporal
Spatial
Logical
Spatial
Logical
Temporal
1
2
3
4
Repetitions. →
Recall After 2 Weeks.
Graph Nº II
[O.K. Young].



Graph No. III.

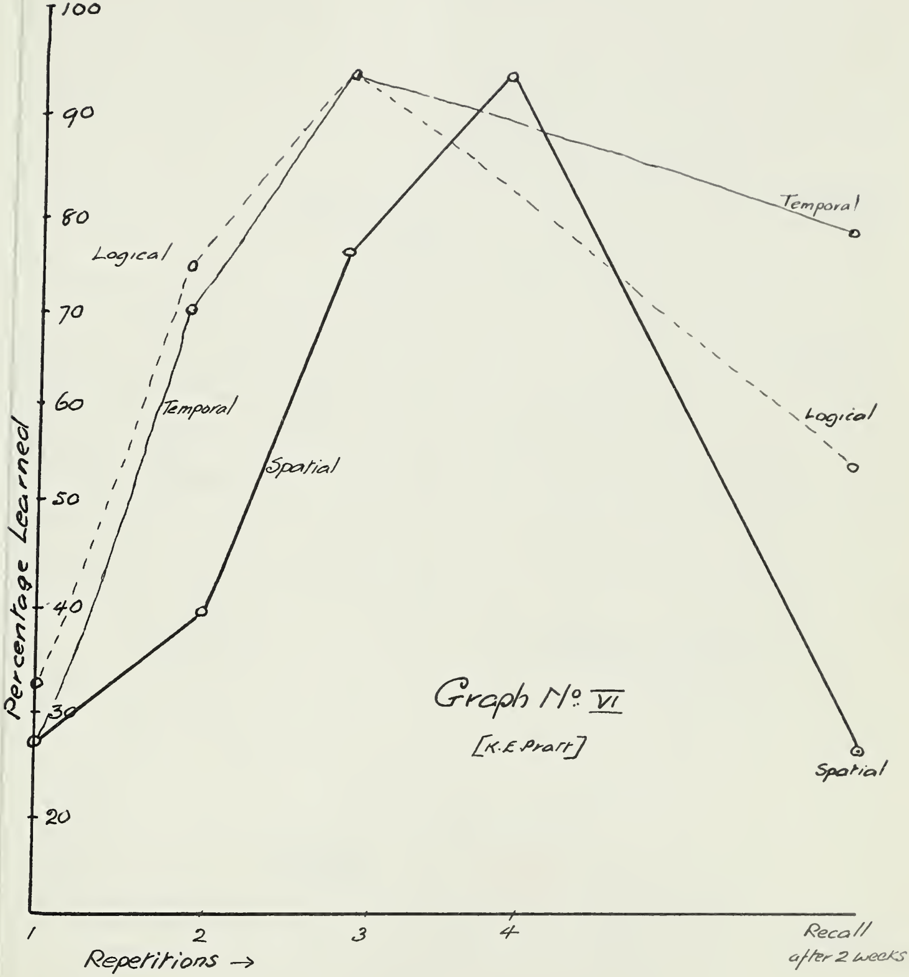
[N.T. Chappell]

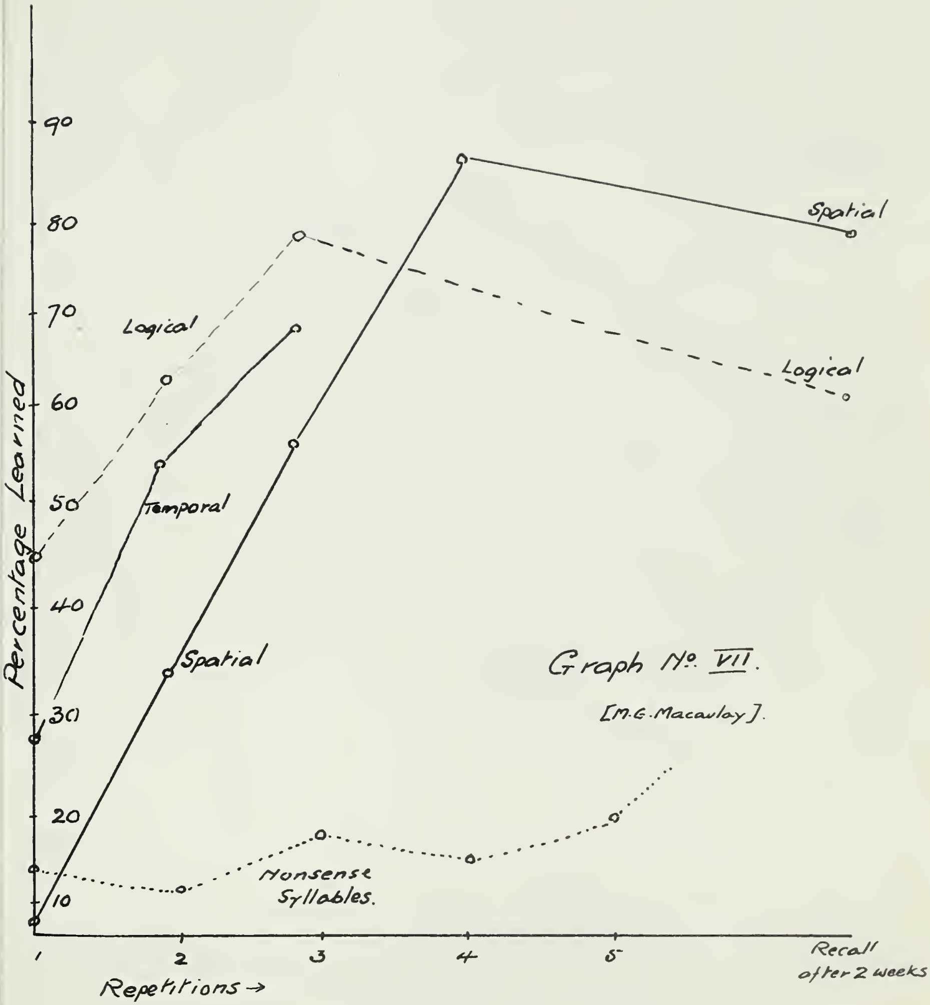

100
90
80
70
60
Percentage Learned →
Temporal
Spatial
Logical.
1
2
3
Repetitions →
Graph No. IV
[R.C Thorpe]

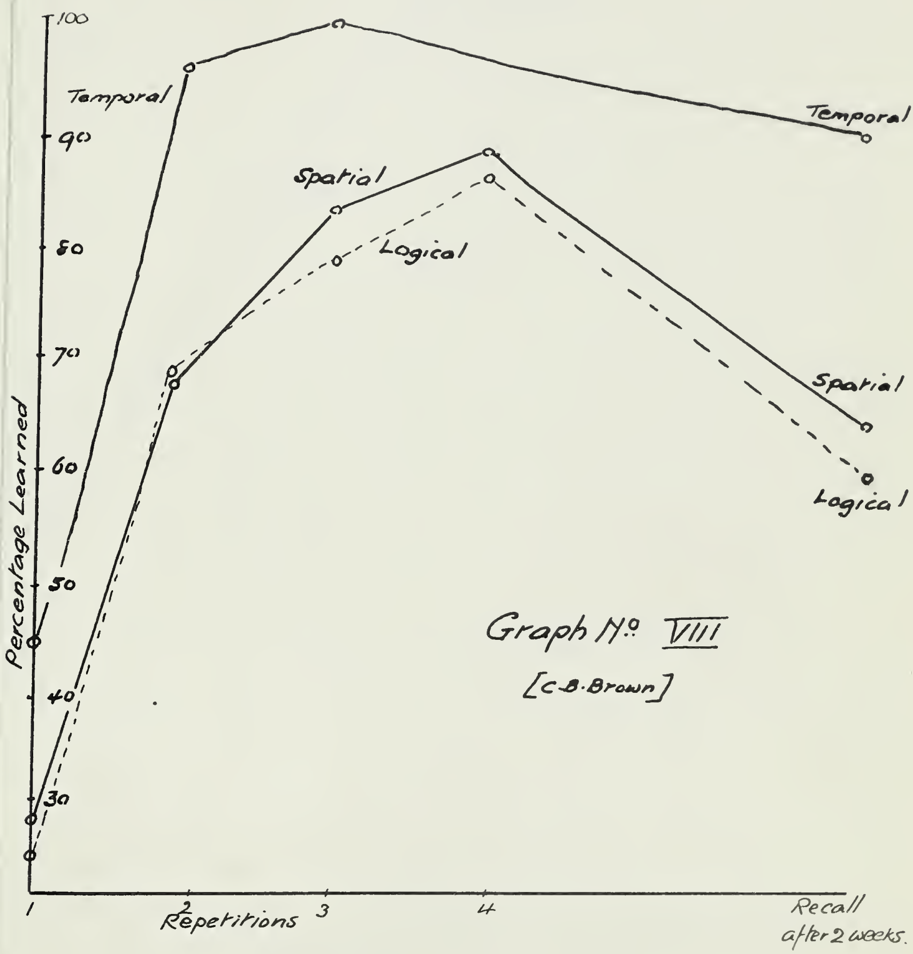


Graph No. V.

[R.C. Hamilton]

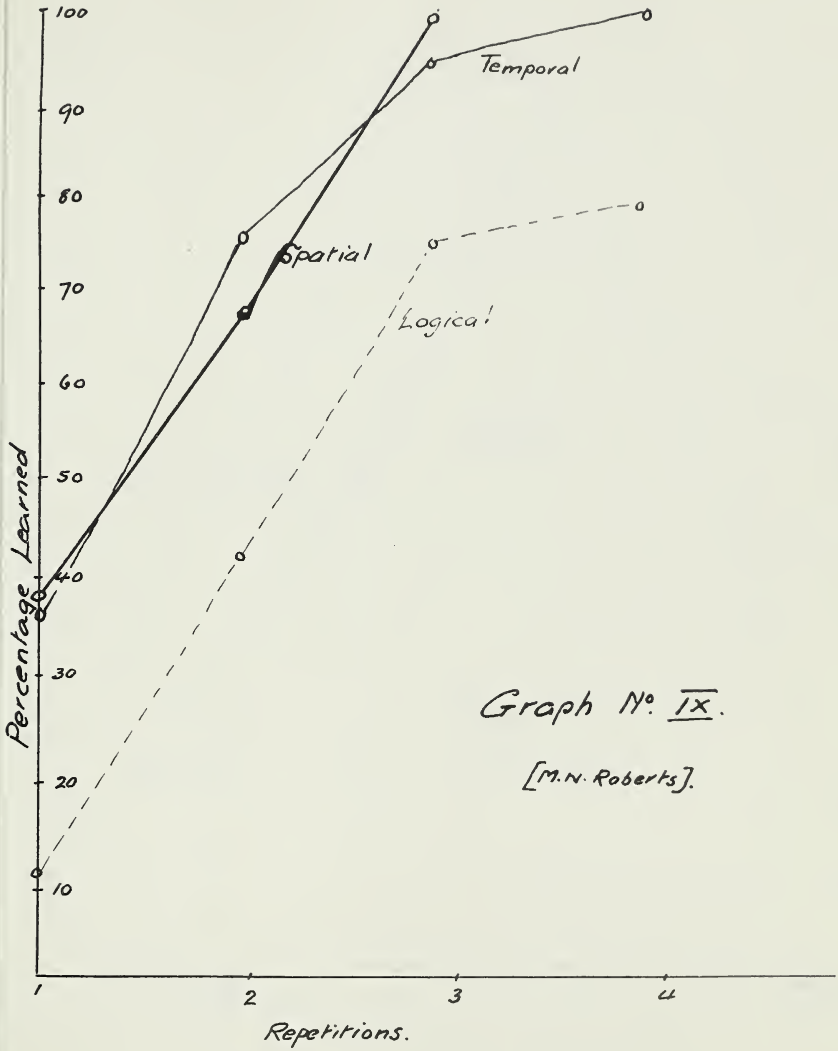

100
90
80
70
60
50
40
30
20
Percentage Learned
1
2
3
4
Recall after 2 weeks
Repetitions →
Logical
Temporal
Spatial
Temporal
Logical
Spatial
Graph No. VI
[K.E.Pratt]


90
80
70
60
50
40
30
20
10
Percentage Learned
Logical
Temporal
Spatial
Spatial
Logical
Nonsense Syllables.
Graph No. VII.
[M.G. Macaulay].
1
2
3
4
5
Recall after 2 weeks
Repetitions →



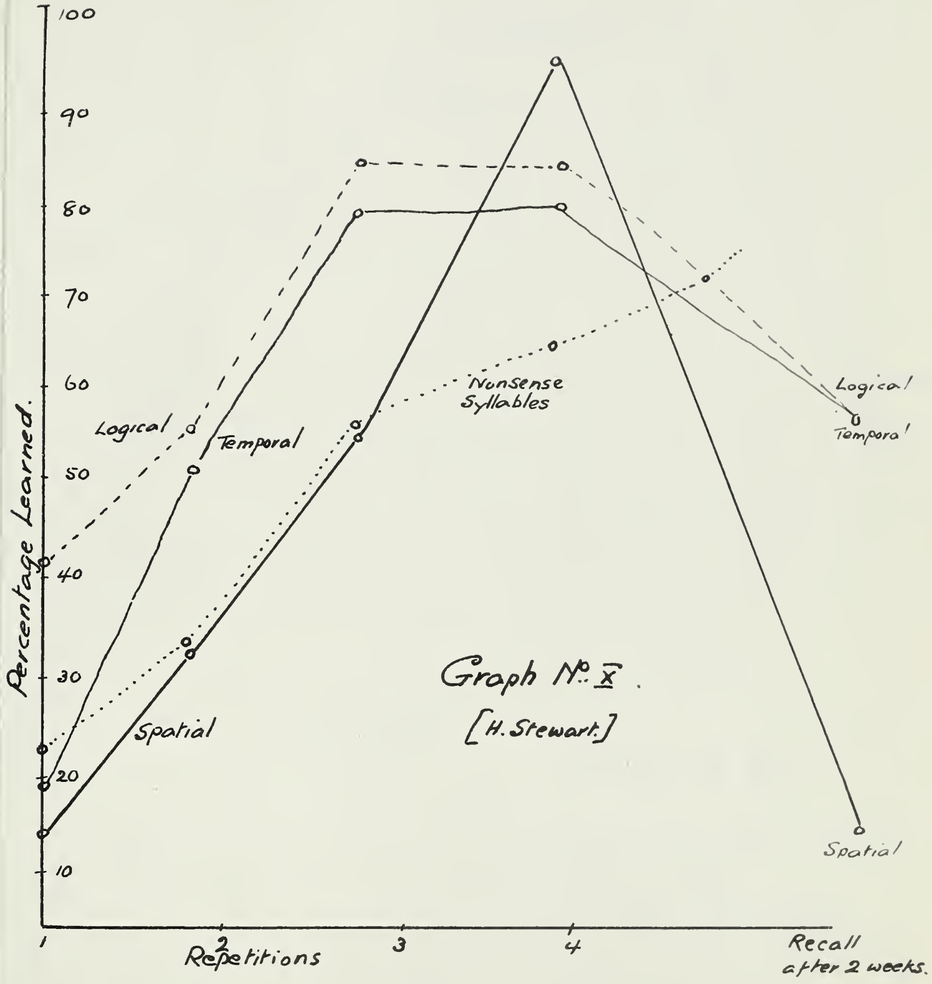
Graph No VIII

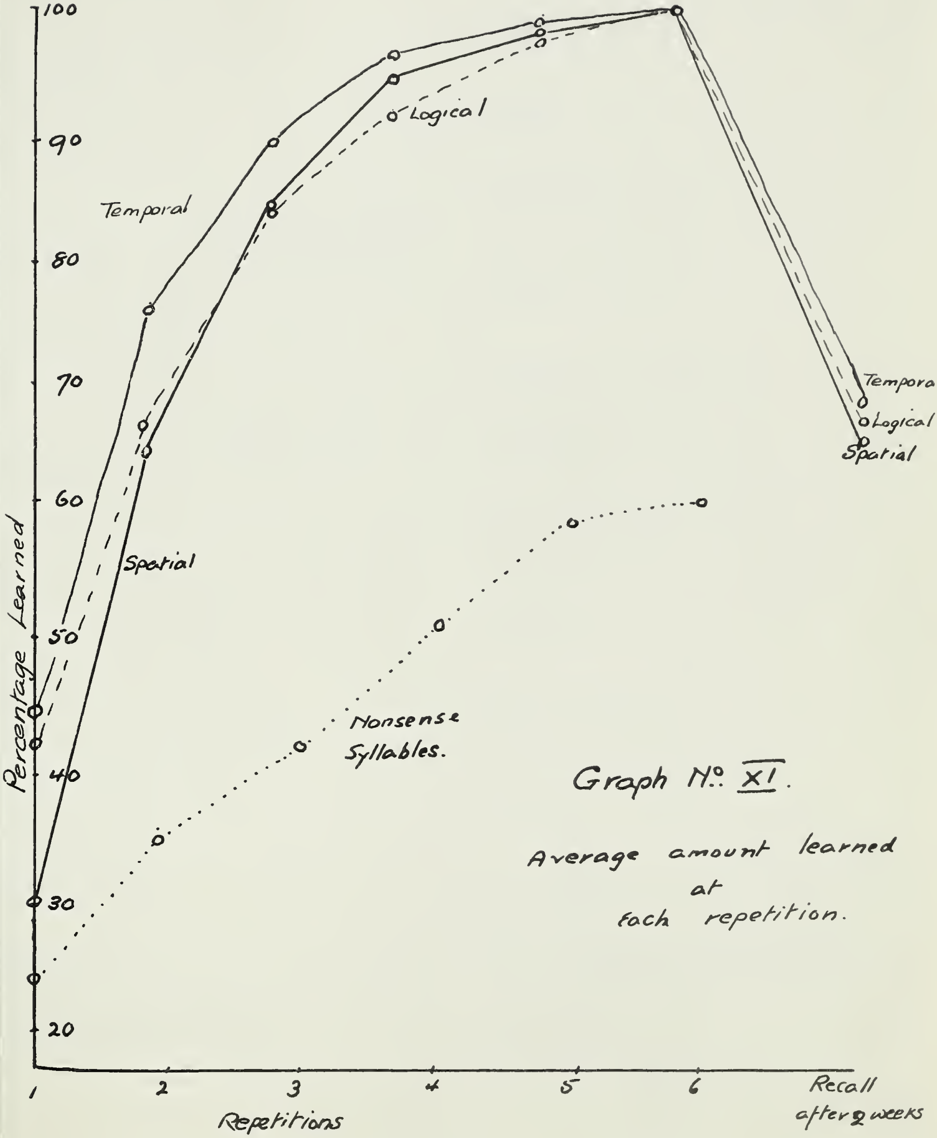
[C.B. Brown]



Graph No. IX.

[M.N. Roberts].


Graph No. X
[H. Stewart.]
Percentage Learned.
100
90
80
70
60
50
40
30
20
10
1
2
3
4
Repetitions
Recall after 2 weeks.
Logical
Temporal
Spatial
Nonsense Syllables
Logical
Temporal
Spatial



Graph No. XI.

Average amount learned at each repetition.

Index of Authors. (The numbers refer to pages)

Aall, 24,25

Abelson,10,12,13

Adams 27

Anderson 11

Ballard, 25,28,29,30,31,60,

Bergson, 34,35,36,37,38,50, 54

Bergstrom,~~[illegible]~~ 10,13

Bernstein,12

Binet,10,11,12,23,25,26

Bingham, 12

Bogdanoff,12

Bolton, 10,12,19

Burt,10,13,19,20

Calkins,Miss,9,10

Carpenter,9,13

Chambers,12

Cohn,11,13

Dell,26

Dieffenbacher,13

Ebbinghaus,12,17,19,20,27, 29,32,67,76

Ebert,12,117

Finzi, 11

Hawkins, 10,12

Henderson, 23

Henri,25,26

Jacobs, 11,12,13

Johnson, 12

Kirkpatrick, 9,10

Kohnky, 12

Krueger, 12

Lapie, 10,12

Lewis, 15,16,17,20

Lobsien, 6,8,9,11,13,14

McDougall,37-45,55-57,65-66.

Meumann,6,10,12,13,15,17, 18-20,65,75,76,117

Muller,13

Munsterburg,13

Netschajeff,6-9,11,13,15

Neumann, 75

Norsworthy, 10

Plato,56

Pohlmann,10-13,63

Pyle,10,11,12,24,26

Quintilian,51,76

Ribot,27,51

Ritter,10,12,13

Rusk,5,6,8,9,11,12,14,15,16, 17,19,27,29,31,32,74, 131,133

Schramm 24

Schumann,13

Schuyten,12

Sharp,10,11,12,13

Shaw, 24,25

Simpson,10,36

Smedley,12

Smith,11,12

Spearman, 12

Springer,17

Squires Mrs. 9,13

Terman,12,25

Thorndike,46

Titchener,131

Toulouse,12

Van Biervliet,13

Vos 24

Watson 33,61

Watt 63,64,74

Wessely,5,17

Whipple,6,10-13,25,26, 63,80-82

Winch 11,17

Wissler 12,23,24,26

Wyatt,11

List of Books Consulted in Preparation of this Essay.

Watson: Psychology from the Standpoint of a Behaviourist.

Meumann: The Psychology of Learning.(English Trans.)

Whipple: Manual of Mental and Physical Tests,Part II.

Rusk: Experimental Education.

McDougall: Body and Mind.

Titchener: Experimental Psychology.Parts I and II

Stratton: Experimental Psychology and its Bearing upon Culture.

Watt: The Economy and Training of Memory.

Bergson: Matiere et Memoire

Ebbinghaus: Memory. (English Trans.)

Ballard: Obliviscence and Reminiscence(Brit.Jour.of Psych. Monograph Supplement)

Starch: Experiments in Educational Psychology.

Cummins: Improvement and the Distribution of Practice.

Breese: Psychology.(Chapter on Memory)

Thorndike: The Psychology of Arithmetic.

Terman: The Measurement of Intelligence.

Bronner: The Psychology of Special Abilities and Disabilities.

Norsworthy: The Psychology of Mentally Deficient Children

Pyle: The Examination of School Children.

Psychological Review, British Journal of Psychology, Journal of Educational Psychology, Amer.Jour.of Psych.

B29738